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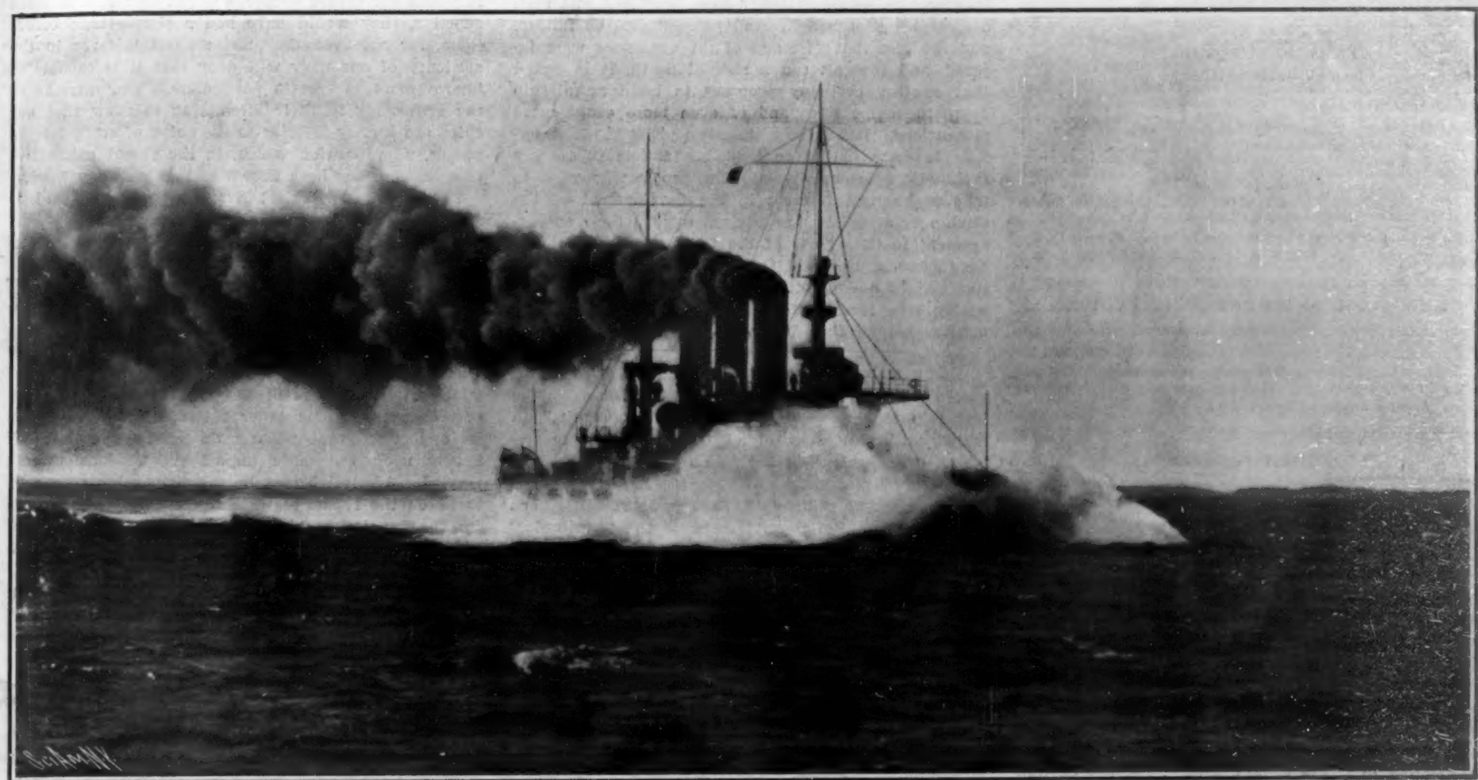

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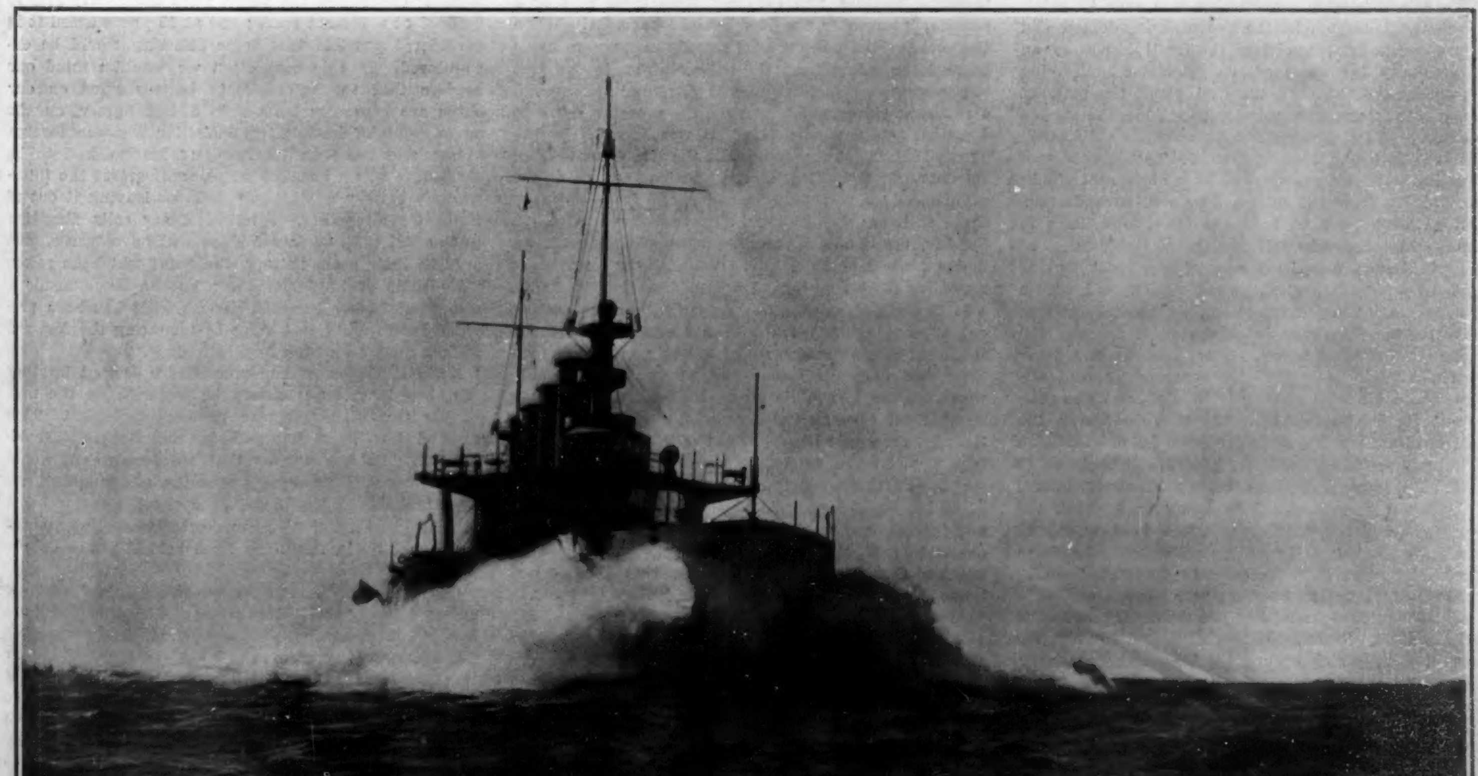
The solid water of this bow wave is fully 18 feet, and the spray 40 feet, above water level.

Bow View of Battleship "Virginia," Taken at Full Speed of 19.04 Knots.



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The size of the bow wave indicates the great resistance to propelling ships at high speeds, and explains in a measure the fact that the resistance to propulsion increases approximately as the cube of the speed.

Bow View of Battleship "Minnesota" on Full Speed Trial.

THE NEW METHOD OF TRYING BATTLESHIPS.—[See page 424.]

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NEW YORK, SATURDAY, JUNE 13, 1908.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

AIRSHIP FOLLIES.

The story of the construction and recent collapse of a huge so-called airship in California has an interest and teaches a moral, which are much broader than the mere locality in which it occurred and the group of deluded people who were more or less concerned in the ill-starred venture. It is a lamentable fact that the development of a great invention seems to be inevitably attended by a large amount of ill-directed effort, involving a great waste of capital, which, had it been applied to the development of really practical designs, would have hastened, instead of hindering, the development of the art. Too often, the really practical inventor is wearing out both his heart and his shoe leather in trying to secure the necessary capital, while the visionary enthusiast is loosening the purse strings of thousands of people who are misled by a fluent tongue and an over-ripe imagination.

This recent airship monstrosity is a case in point. The design betrayed, in the proportions adopted and in the method of applying the motive power, an extraordinary ignorance of the principles underlying airship construction. In the first place, the ratio of diameter to length was quite impracticable, the airship being only 34 feet in diameter for a length of 485 feet, a ratio of 1 to 14. This long, snake-like bag possessed no rigidity either in a vertical or a horizontal plane; and, judging from the photographs and such descriptions as have come to hand, no effort was made to stiffen it by any adequate system of trussing. The lack of rigidity has been one of the most serious problems attached to airship construction, and with a view to preventing deformation, or partial collapse under sudden shrinkage or expansion of the gas due to changes of temperature, Santos-Dumont and other experimentalists have provided separate internal air-bags, which are kept constantly inflated, so as to compensate for the shrinkage of the gas. Moreover, the vertical alinement has been protected by providing an underhung working platform, generally triangular in section and possessing considerable vertical and lateral stiffness. Care has also been taken to so hang the platform from the balloon that the load would be evenly distributed; and longitudinal swaying has been prevented by attaching the platform to the balloon by a system of triangulated netting and ropes.

As distinguished from these precautions, the wrecked balloon seems to have been designed to invite the very disaster which occurred. According to the reports which have reached us, six separate power plants, each consisting of a 4-cylinder, 40-horse-power engine, were hung below the balloon at stated intervals. No adequate attempt was made to distribute these concentrated loads. Apparently, they were carried on a sort of canvas runway, which was supported within the netting which covered the airship. Special ropes seem to have been carried around the gasbag at the points where the engines were located; but the photograph shows that these ropes cut deeply into the bag, as was to be expected. Now, a gasbag of this enormous length and relatively small diameter should have been strengthened by a vertical framework, or rope and wire trusswork of considerable rigidity; but no provision whatever of the kind appears to have been made. With such a great increase in length, moreover, the stresses due to steering control, either in a vertical or horizontal plane, were greatly augmented; yet apparently no special effort was made to meet these stresses. It was inevitable that the long-drawn-out affair would get out of control; and it appears from the published accounts that this speedily happened, the airship assuming a sharply-inclined position. The rush of gas to the upper end of it, which naturally followed, proved too much for the strength of the envelope material, which burst open, allowing the gas to escape and letting the whole affair drop to the ground.

It is positively amazing that the lives of nearly a score of men should have been intrusted to such a ridiculous construction as this. Any really practical aeronau such, for instance, as Capt. Baldwin or Mr. Knabenshue, would probably have predicted just such a collapse as occurred. And yet, despite the failure, and the fact that so many of the occupants were injured, and that all ran a risk of death, it is stated that another company proposes to build an airship along the same lines and of even more exaggerated proportions. It will be a thousand pities if the American investor is led to lend his assistance to any such wild scheme as this. The people who wish to take a practical interest in the development of the airship or aeroplane are advised to give their encouragement to the efforts of the few practical men who have demonstrated that they have the necessary scientific insight and practical mechanical ability to measurably help forward the art of aeronautics in every machine which they build.

A MARINE STEAM TURBINE ANOMALY.

A decidedly puzzling anomaly is presented by the last trip to the westward of the "Mauretania," in which, with only three of her four propellers in service, she not only beat her own record over the long course by 3 hours and 47 minutes made with her full complement of four turbines and propellers, but even surpassed the recent record of the "Lusitania," covering the distance in 4 days, 20 hours and 12 minutes at an average speed of 24.86 knots, as against an average speed of 24.83 knots, made by the sister ship.

On her previous trip to the westward, the "Mauretania" lost a blade from her port high-pressure turbine propeller, and rather than delay the sailing of the boat it was decided on her return to Liverpool to take off the propeller altogether, shut down the port high-pressure turbine, and let the ship come across under one high-pressure and two low-pressure turbines and three propellers. It will be remembered that the motive power consists of two units each consisting of an outer high-pressure and inner low-pressure turbine. The steam is led from the boilers to the high-pressure turbines, and exhausts from them at 4 or 5 pounds pressure to the low-pressure turbines. When the port turbine was cut out, arrangements were made to lead the steam from the boilers direct to the port low-pressure turbine, to which it was admitted through a reducing valve, which brought the pressure down to 4 pounds to the square inch. It was expected by the agents that the ship would make the trip at a speed of between 23 and 23½ knots. Instead of this, she commenced to show unexpected speed from the very first, and on the 25-hour day ending at noon on Sunday, she made a record run of 635 miles at an average speed of 25.40 knots, maintaining an average speed for the whole trip of a little less than 25 knots.

It is certainly a startling anomaly that the cutting out of one turbine should have apparently increased the speed of the "Mauretania," but as a matter of fact, there are causes external and internal to the ship which go far to explain this. In the first place, the weather all through the past winter has been exceptionally severe; whereas the weather on the recent trip was, on the whole, decidedly favorable to high speed. Furthermore, the bunkers contained a grade of Welsh coal of exceptionally good steaming quality, and there seems to have been an abundance of steam available throughout the whole trip. As far as the engines themselves are concerned, that the normal horse-power was maintained, and probably exceeded, in spite of the fact that one high-pressure turbine was cut out, simply furnishes additional proof of the fact that the great efficiency of the turbine lies in the lower end of the expansion, that is to say, in the low-pressure turbine. It is well understood that the efficiency of the high-pressure end of the turbine is as low as the efficiency of the low-pressure end is high. This is due to the fact that the leakage is higher relatively to the blade area, and that because of the greater density of the steam the windage is much greater in the high-pressure than in the low-pressure turbine. Moreover, there would be a certain conservation of heat in feeding steam direct to the low-pressure turbine. Although all these facts together serve as some measure of explanation of this extraordinary run of the "Mauretania," they certainly leave room for the confident prediction of the captain and engineer that, under ideal weather conditions and with all four turbines in operation, and with a good quality of coal, the ship will make the passage at an average speed of 26 knots. This, over the northerly, or short course, would bring her across in less than four and a half days.

ADMIRAL EVANS'S REPORT ON THE NEEDS OF OUR SHIPS.

Admiral Evans's report, based upon observation of the behavior of our ships during their long voyage to the Pacific coast, is marked by an impartiality which comes in refreshing contrast to much of the discussion of the alleged defects of our warships during the past six months.

The cardinal mistake made by the critics of our navy was that they attempted to prove too much. Had they been content with pointing out certain elements in which our future warships might be rendered more effective, they would have had a simple task before them, for not even the most zealous believer in the efficiency of our navy will deny that it is capable of improvement in certain particulars. The mistake of the critics lay in their attempting to show that our ships are greatly inferior to the ships of some foreign navies, a proposition which, in the recent exhaustive examination, has been shown to be absolutely false.

The report of Admiral Evans, as we have said, is strictly impartial. It deals with our ships as they are, without any reference to what the ships of foreign navies may or may not be. The recommendations of the report are based upon the carefully compiled observation of one of our most talented naval constructors, who was detailed to accompany the ships especially for the purpose, and from reports of the various officers of the ships themselves. When we state that the report of Naval Constructor Robinson embodies suggestions under 144 separate heads, it can be understood that we can do no more than touch briefly upon the more important questions therein treated. Admiral Evans in submitting his own comment on the report states that, except in one or two instances, noted in his letter, he heartily approves of the general opinions expressed by Constructor Robinson.

In the first place, it is strongly recommended that vessels designed to operate together should be strictly homogeneous in tactical and steaming qualities, and that they should be built in classes of four vessels as a minimum number.

On the subject of freeboard, it is considered that the intermediate battery guns of the fleet are too low for efficiency. When steaming at 10 knots with an ordinary trade wind anywhere forward of the beam, it is necessary for comfort and to prevent occasional flooding of the gun deck to keep the weather guns secured with shutters in place. Under the same weather conditions, the turret guns can nearly always be fired at a 10-knot speed; but at 15 knots speed it is considered possible that some difficulty would be encountered. In this connection we would remind our readers that the intermediate battery guns on our ships are generally from 1 to 2 feet higher, on the same depth of loading, than similar guns on foreign ships; and since an intermediate battery had to be carried, it was a question of placing part of the intermediate battery on the gun deck, or leaving it out of the ships altogether. Admiral Evans calls attention to the fact that, as future ships will have turret guns only in their main battery, the point which he raises loses some of its importance; but he recommends a somewhat higher turret forward. This has been provided for in our latest ships by mounting the forward 12-inch guns on a high forecastle deck.

Admiral Evans recommends that a part at least of the torpedo defense battery be mounted on the tops of the two higher turrets in our new ships. This method has been followed in the British "Dreadnoughts"; but we consider that, since such guns would be entirely without armor protection, and would, therefore, probably be disabled in a general engagement, it is quite a question whether the balance of advantage would not lie in mounting them behind armor on the gun deck.

On the all-important question of the location of the armor belt, Admiral Evans says: "Judging from the figures contained in the several replies from commanding officers which relate to this subject, it would appear that better protection might have been afforded had these belts been originally placed between 6 inches and 1 foot higher. . . . But even this is open to question, for it has been noted that even when heavy laden and in the smooth to moderate seas which have thus far characterized this cruise, the ships frequently exposed their entire belt and the bottom plating beneath it. It must be remembered that even a 5-inch or a 6-inch shell (of which there would be a great number) could inflict a severe and dangerous injury if it struck below the belt; while otherwise the waterline, even with the belt entirely submerged, is, on account of the casemate armor and coal, immune to all except the heaviest projectiles."

It is recommended that the waterline belt be curved upward at the bows, so as to cover both sides in the forward portion of the ship with 2-inch or 3-inch armor

as protection against the smaller caliber shells, and that additional protection be given to the steering gear.

Except for flagships, on which an after bridge and an emergency cabin are essential, Admiral Evans considers that all flying bridges and after bridges are unnecessary and are a menace in action. He believes that the present forward bridge, with portable extensions on each end extending out at the side, is the most desirable type, the conning tower being used as the habitual steering position, with a wheel on the top and a rail around the conning tower, thereby affording a suitable position from which to pilot the ship.

Much stress is laid upon the proper design of the conning tower, and it is considered that this very important battle station should be large enough to permit of its habitual use for steering the ship at all times; that it should be elliptical in shape, extending athwartship far enough to permit a clear view directly astern. It should be directly over the central station, and connected to it by a thick armored tube large enough to permit a man to pass through. Furthermore, it should be large enough to accommodate the flag officer, for whom, at present, no armored position is provided. The report recommends the adoption of a cagework mast, specially constructed to resist being cut away, with a small armored tube extending from the spotter's station on the fire-control platform down to a point below the ship's armor. On the question of turrets the Admiral recommends the electric turret-turning gear of the type mounted aboard the "Maine" as being the best yet installed; and unless the compressed-air system of loading the guns proves to be successful, he considers the two-stage hoist to be the best, both as regards safety and rapidity, which now offers. It is considered advisable to place the turrets under air pressure, with a view to expelling the gases when the breach is opened. Attention is invited to the importance of fitting adequate means for hoisting turret ammunition by hand.

With regard to propelling machinery, the Admiral believes that the adoption of turbine machinery must soon take place, but he agrees with Naval Constructor Robinson that, in its adoption, care must be taken not to sacrifice those tactical and maneuvering qualities that are essential to the proper handling of ships, not only as single vessels but as units in a fleet. On the question of ammunition supply, although Admiral Evans believes that in one or two instances ordnance officers have requested a supply in excess of the actual demand, he states that the ships now in commission can only in special cases supply ammunition to the various guns as rapidly as it can be fired. This condition is largely due to the increase of the rapidity of fire since the ammunition supply systems were designed. He would favor providing an ammunition supply system which, on a short test, would supply ammunition at a rate equal to the average shots per minute on the record practice.

OUR AEROPLANE TESTS AT KITTY HAWK.

BY ORVILLE AND WILBUR WRIGHT.

The spring of 1908 found us with contracts on hand, the conditions of which required performance not entirely met by our flights in 1905. The best flight of that year, on October 5, covered a distance of a little over 24 miles, at a speed of 38 miles an hour, with only one person on board. The contracts call for a machine with a speed of 40 miles an hour, and capable of carrying two men and fuel supplies sufficient for a flight of 125 miles. Our recent experiments were undertaken with a view of testing our flyer in these particulars, and to enable us to become familiar with the use of the controlling levers as arranged in our latest machines.

After tedious delays in repairing our old camp at Kill Devil Hills, near Kitty Hawk, N. C., we were ready for experiments early in May. We used the same machine with which we made flights near Dayton, Ohio, in 1905; but several modifications were instituted to allow the operator to assume a sitting position, and to provide a seat for a passenger. These changes necessitated an entirely new arrangement of the controlling levers. Two of them were given motions so different from those used in 1905 that their operation had to be completely relearned.

We preferred to make the first flights, with the new arrangement of controlling levers, in calm air; but our few weeks' stay had convinced us that in the spring time we could not expect any practice at that place in winds of less than 8 to 10 miles an hour, and that the greater part of our experiments must be made in winds of 15 to 20 miles.

The engine used in 1905 was replaced by a motor of a later model, one of which was exhibited at the New York Aero Club show in 1906. The cylinders are four in number, water cooled, of 4¼-inch bore and 4-inch stroke. An erroneous statement, that the motor was of French manufacture, has appeared in some papers. This is, no doubt, due to the fact that we are having duplicates of this motor built by a well-known Paris firm, for use in European countries.

The longer flights this year were measured by a Richard anemometer attached to the machine in the same manner as in 1905. Except in the first few flights, made over regular courses, it was found impracticable to secure accurate measurements in any other way. These records show the distances traveled through the air. The measurements of the velocity of the wind were made at a height of six feet from the ground at the starting point, and were usually taken during the time the machine was in flight.

The first flight was made on the 6th of May, in a wind varying from 8 to 12 miles an hour. After covering a distance of 1,008 feet measured over the ground, the operator brought the machine down to avoid passing over a patch of ground covered with ragged stumps of trees.

In the morning of May 8 several short flights were made in winds of 9 to 18 miles an hour. In the afternoon the machine flew 956 feet in 31 seconds, against a wind of a little over 20 miles an hour; and later, a distance of 2,186 feet in 59¼ seconds, against a wind of 16 miles. These distances were measured over the ground.

On May 11 the Richard anemometer was attached to the machine. From this time on the flights were not over definite courses, and the distances traveled were measured by this instrument. Three flights were made on this day in winds varying from 6 to 9 miles. The distances were: 0.78 mile, 1.80 miles, and 1.55 miles.

On May 13 four flights were made. The anemometer on the machine registered a distance of 0.60 mile in the first; 1.85 miles in the second; no distance measurement in the third—time, 2 minutes and 40 seconds; and 2.40 miles in the fourth. The velocity of the wind was 16 to 18 miles an hour.

On May 14 Mr. C. W. Furnas, of Dayton, Ohio, who was assisting in the experiments, was taken as a passenger. In the first trial, a turn was not commenced soon enough, and to avoid a sand hill, toward which the start was made, the power was shut off. The second flight, with passenger on board, was in a wind of 18 to 19 miles an hour. The anemometer recorded a distance traveled through the air of a little over 4 kilometers (2.50 miles) in 3 minutes and 40 seconds.

The last flight was made with operator only on board. After a flight of 7 minutes and 29 seconds, while busied in making a turn, the operator inadvertently moved the fore-and-aft controlling lever. The machine plunged into the ground, while traveling with the wind, at a speed of approximately 55 miles an hour. The anemometer showed a distance of a little over 8 kilometers (5 miles).

The frame supporting the front rudder was broken; the central section of the upper main bearing surface was broken and torn; but beyond this, the main surfaces and rudders received but slight damage. The motor, radiators, and machinery came through uninjured. Repairs could have been made in a week's time, but the time allowed for these experiments having elapsed, we were compelled to close experiments for the present.

These flights were witnessed by the men of the Kill Devil life-saving station, to whom we were indebted for much assistance, by a number of newspaper men, and by some other persons who were hunting and fishing in the vicinity.

The machine showed a speed of nearly 41 miles an hour with two men on board, and a little over 44 miles with one man. The control was very satisfactory in winds of 15 to 20 miles an hour, and there was no distinguishable difference in control when traveling with, against, or across the wind.

DEATH OF FRANCIS B. STEVENS.

Mr. Francis B. Stevens, one of the pioneer inventors in the field of transportation, died May 23, 1908, at the age of ninety-three. The first steam screw ship constructed by his family was built shortly before his birth, and he grew up in an atmosphere of ships, docks, engines, and railways, which make the name of Stevens a part of the history of transportation as we know it to-day. As a youthful engineer he ran a complete line of levels over the right of way of the Camden and Amboy Railway, producing one of the earliest known railway profiles. During his many years' service as an engineer in charge of the marine shop of that railway, he lived to see its evolution into the Pennsylvania system of to-day. In this shop he built some of the earliest steam-propelled vessels, and in their design made free use of multiple screws, the advantages of which were very apparent. He also designed and built steeple compound engines, in which the low-pressure cylinder was placed above the high-pressure cylinder, with special arrangements for making all parts of the machinery accessible, designing for these engines a single piston valve. After seventy years of service he designed and constructed the last of the side-wheelers built for the North River ferry service. He invented the cut-off that remains the usual valve motion for the marine beam engine. He was very active in the government tests of steam boilers, and he established the value of formulas used for determining their proportions. As far back as 1884 he advocated a salt-water pumping plant and a system of distributing mains for the protection of lower New York, and this same system will shortly be put into operation. He died within sight of the Stevens Institute of Technology, established by his uncle, and which had conferred upon him the degree of doctor of engineering. He is survived by his widow, a daughter, and two sons.

DEATH OF MISS TYLER.

The death of Miss Amelia Tyler, which occurred on the 23d of May, 1908, at her home in Washington, D. C., has caused widespread regret and sincere mourning among her friends and associates.

Miss Tyler was the grand-daughter of Chief Justice Royall Tyler, of Brattleboro, Vt., and was born in Connecticut in 1832. Her father was the Rev. Edward Tyler, a Congregational minister of fine attainments. One of her uncles was Judge Royall Tyler of the Probate Court, and her nephew, a graduate of the Naval Academy, is the present Assistant Commissioner of Patents.

She was the last survivor of her immediate family and is buried at Brattleboro, Vt., among her own people in Prospect Hill Cemetery.

Her first years in office were spent in the General Post Office, and in 1881 she came into the United States Patent Office, which was the final scene of her life work. In competitive examinations she won the position of an Assistant Examiner, being one of the first three women thus appointed, and one of her fellow examiners says:

"She entered Division One on the 10th of October, 1881, and remained an efficient and faithful assistant until the day previous to her death. She handled a large class—'Trees, Plants, and Flowers' under the general division of Tillage—and was a skilled botanist."

FUTURE FOREIGN POSTAGE REDUCTION WITH GREAT BRITAIN AND COLONIES.

The gratifying announcement is made from Washington that Postmaster-General Meyer, with the approval of President Roosevelt, has concluded arrangements with the postal authorities in Great Britain, whereby the ocean foreign postage on first-class mail matter, which covers letters, is to be reduced from five cents an ounce to two cents an ounce on and after October 1, 1908. This is the present domestic rate in the United States and its foreign possessions. It is to be hoped the next improvement will be the decrease in rates on parcels sent *via* parcel post.

THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1693, contains a number of articles of unusual interest. The first-page engravings relate to the sinking of a concrete mine shaft on an entirely new system. This concrete mine shaft is a striking illustration of the complexity of modern anthracite mining as compared with the simple methods of former days. "Why Are Eggs Colored?" is a fully-illustrated article dealing with the curious phenomena of shell pigmentation. "Nerve as a Master of Muscle" is by Prof. Sherrington, F.R.S. "The Story of the Tobacco Pipe" gives the evolution of the pipe from primitive days. In every clime and country the fumes of tobacco are inhaled through some kind of pipe, and a collection of the world's pipes will contain more types of peculiarity than there are nations or tribes upon the face of the earth.

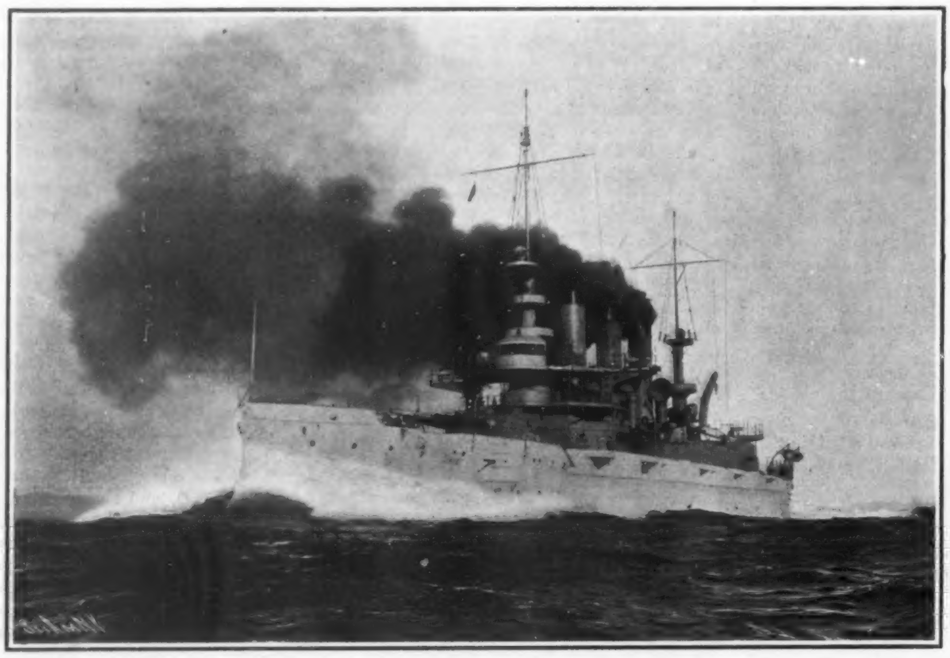
SCIENCE NOTES.

William A. Anthony, professor emeritus of physics, electrical and mechanical engineering at Cooper Union, died in New York May 30 at the age of seventy-three years. He was born in Coventry, R. I., and was graduated from Yale. For eighteen years he taught physics in the Iowa Agricultural College and in Cornell. At the end of that period he established himself in business as consulting engineer, and in 1895 he became a teacher in Cooper Union.

It was announced at a session of the International Polar Cogress held at Brussels, that an American intended to start on an expedition to the south pole under plans worked out by Commander Peary, although the latter would not be a member of the exploring party. Peary's old ship, the "Roosevelt," is to be used on this expedition. The party plans to start in the fall, to spend the winter on the north shore of Grant Land, and from there to make a dash for the pole in 1909. To shorten the distance a hundred miles and to escape the effects of the eastern currents a route along the coast of Grant Land will be followed. Commander Peary suggests a visit to Crocker Land, on the return trip, a section of the unknown world, the exploration of which he thinks may revolutionize the present ideas regarding the untraversed polar regions. The name of the American who is to make the voyage was not given.

THE NEW METHOD OF TRYING BATTLESHIPS.

When the newest prospective addition to the United States navy leaves the builders' works for the speed trial trip, all the machinery and working parts have been freshly examined and put in the best possible condition for the test. The builders have had the ship's bottom carefully cleaned and gone over with the most efficient anti-fouling paint; and have had the bunkers filled with hand-picked steaming coal, stored in bags. The crew, especially those in the engine and fire rooms, are men selected for their skill and endurance. The firemen usually taken are those who have fired on transatlantic liners, and consequently are accustomed to keeping steam at highest pressure. These men are employed by the builders, as the cost of making the speed trial trip is included in the contract price of the vessel. The shipyard people also provide caterers to feed all their men and all the government representatives that are on board. Recently, there were on a battleship during its trial five hundred and two men besides the members of the trial board and their assistants. Of these, two hundred and seventy-nine were in the engineer's department, one hundred and two in the steward's, thirty-eight were shipyard and government representatives, and the remaining eighty-three were foremen, special workmen, and the deck force.



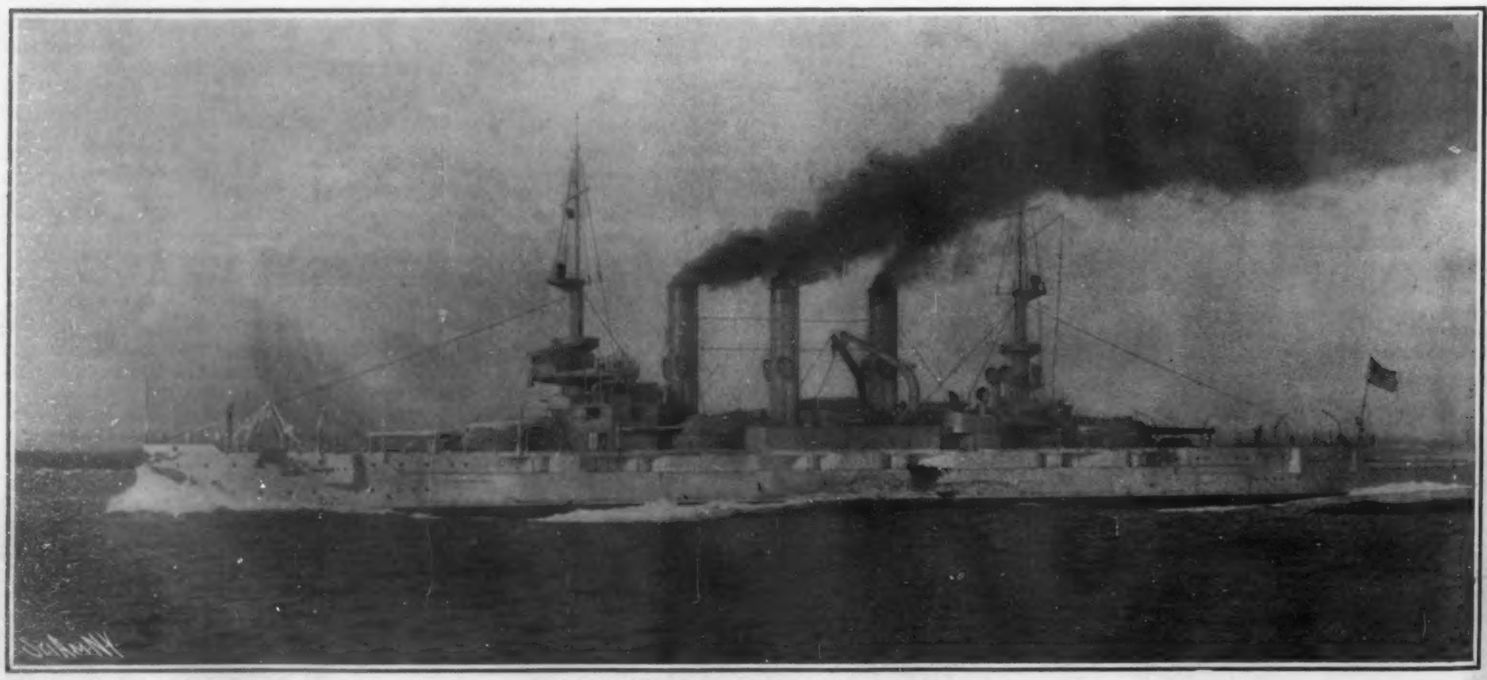
Battleship "Minnesota" on Trial Course off Rockland, Maine, Making 18.8 Knots.

The vessel to be tried, having on board all the crew, the shipyard officials, and the government inspectors of construction, leaves the builders' works in ample time to reach Rockland, Me., the day before that set for the trial. During the run along the coast the builder's people usually have the ship make a preliminary canter, to satisfy themselves concerning the vessel, and to make certain that the engines are in condition to do the work cut out for them.

The contracts made by the Navy Department with shipbuilders for the construction of men-of-war contain a principal requirement specifying the average speed to be attained by the ship during a speed trial of four hours' duration. This has been eighteen or nineteen knots for battleships, and twenty-two knots for armored cruisers. The trial is conducted by the builders and supervised by a board of naval officers detailed by the Navy Department to see that it is carried on according to the contract. Under the old system a speed bonus was paid; but nowadays no bonus is paid for speed in excess of that called for, though severe pecuniary penalties are imposed for failure to meet the speed requirements. This penalty for the newly-completed ships has been at the rate of $200,000 per knot for the first quarter below the contract speed, and at the rate of $400,000 per knot if the speed falls more than one quarter knot below that required. It will be seen therefore how important it is to the contractors that the ship should attain the speed specified in the contract, and that the government is interested in determining what the speed obtained is. If the first trial is not satisfactory others may be required, and as these trials are very expensive to the builders they are naturally very anxious to avoid repetitions. It was customary, up to a short time ago, to conduct speed trials along Cape Ann over a measured course of forty-four miles marked with buoys at intervals and at each end. As shoal water retards the speed of large vessels, the Cape Ann was a deep-water course, and for that reason it was difficult to keep the buoys marking it in position. It had also numerous tidal and other currents for which it was necessary to allow, as a ship held back or helped by such currents showed a different speed from that which would have been obtained in still water. It was very recently decided to abandon this method of conducting speed trials in favor of a new one, known as the "Method by Standardized Propeller." Essentially, this consists of determining the speed at which the vessel will go for a certain average number of revolutions of the propeller, and then making a four-hour full-speed run in the open sea, and ascertaining the speed attained from the average number of revolutions of the propellers.

The first step, that of standardizing the propeller or screw, is the most important, as the correctness of the final result rests entirely on its accuracy. A measured one-mile course has been arranged in the outer harbor of Rockland, Me. Here the depth of water is sufficient to insure that there will be no retardation due to shoals. The vessel is run over this course in two directions at each of several speeds, and the results averaged. The reason for this is that any effect of tide or wind helps in one direction and retards in the other, so that the average is necessary to eliminate errors. The time on the course and the number of revolutions of the propellers are painstakingly determined for each run. The ends of the course are marked by range poles on shore; and when the observers, of whom there are three in different parts of the ship, see these poles in line each presses a stop watch, and with the same motion makes an electrical contact by means of a machine, especially designed for the purpose, which prints the revolutions of the propellers. By having the observers in different parts of the ship three separate observations are obtained, and if any one of them varies from the other two more than three-tenths of a second, it is discarded. The results are reduced to a curve, from which it is possible to determine what speed the vessel will make for any number of revolutions per minute. This applies only to the vessel at a given displacement. The contract specifies the displacement for the speed trial; and as a quantity of coal and fresh water for the boilers is used during the run, this must be compensated for by adding enough excess weight to make the average displacement for the four hours that required. All the details are worked out with great accuracy, so that the results may be absolutely reliable.

During the trial trip it is customary to try all the auxiliary machinery. The anchor engine is tested by hoisting both anchors with the entire chain out—the severest possible service that could be required of it; the length of an anchor chain being one hundred and twenty fathoms, or seven hundred and twenty feet, and the weight of two battleship anchors about sixteen tons. The steering engine is tested with the vessel at full speed by putting the rudder from one side to the other, or, as it is called, putting the helm from hard over to hard over. If it is strong enough to do that, the hardest work a steering engine ever has, in twenty seconds, it is considered satisfactory. The vessel is next turned at full speed, and the time taken for a turn through three hundred and sixty degrees or a complete circle. As a conclusion to these tests of the



Battleship "Kansas" on Full Speed Trial. Speed, 18.09 Knots.

THE NEW METHOD OF TRYING BATTLESHIPS.

rudder and steering engine, while the vessel is going astern at full speed, the rudder is brought to the various positions from amidships to hard over. This, the hardest test of all, if satisfactorily met proves that the steering appliances are sufficiently strong in their various parts.

Among the lesser auxiliary machines examined are: ventilating blowers and pumps; the electrically-operated doors, winches, and ammunition hoists, which are run under conditions simulating actual service; turrets are turned, and in general a complete test of all working parts is made.

Upon arrival of the vessel at Rockland the builders' representative, usually the president or general manager of the company, reports to the president of the trial board, a rear admiral in the navy. Early the next morning the board and its assistants, about thirty in number, go to the ship and start the first day's work, consisting of standardizing the propeller. These runs are made over the one-mile course inside Rockland harbor. Twelve or fifteen runs are made in the two directions at speeds ranging from highest to about two-thirds. The three observers, members of the board, have positions each in electrical communication with the others and with the recording apparatus on the propeller shaft; also each has an assistant who records observations, verifies and forwards them to the computer to be arranged for final tabulation and curve plotting. This last must be done promptly, in order that it may be known whether additional runs are necessary to complete the data.

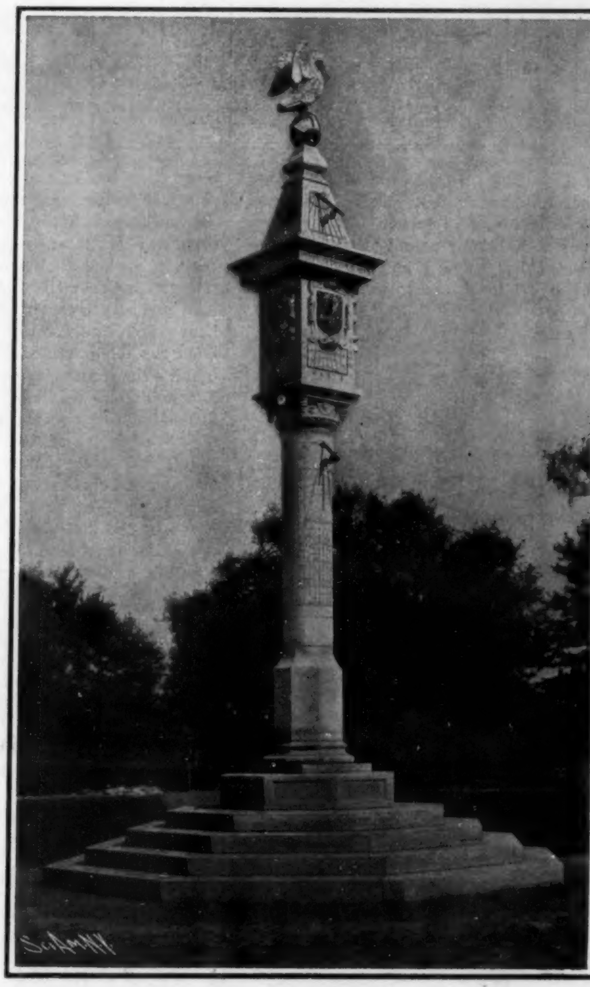
In the engine room members of the board and assistants are detailed to observe the speed and performance of the main engines, pumps, and other auxiliaries, and to take indicator cards. In the fire rooms observations are made of the working of the boilers, count is kept of the number of bags of coal used, temperatures are taken throughout, and the operation of the forced draft is noted. After the standardizing runs, before the vessel is anchored for the night, the test of the anchor-handling appliances is made; meanwhile the computers finish compiling the data, and the speed curves are laid out. From the curves is determined the number of propeller revolutions required per minute for the vessel to attain the prescribed speed, and the builders know what the engines will be called on to do during a four-hour trial.

At night the fires are cleaned, all the machinery is carefully gone over and oiled; the firemen and engineers are given a good rest with plenty of food, that they may be in condition for the next day's hard work.

The day of the four-hour trial, if the weather is favorable, anchors are weighed early and the ship headed for the open sea. The engines are slowly worked up, and when all is ready the four-hour, full-power speed trial commences. Revolution counters register every turn of the propeller shafts on dials, and at thirty-minute intervals these are read, and from them the average revolutions per minute determined. All the working parts are carefully watched and oiled, the amount of lubricating oil used during a recent trial being about five hundred gallons. If at any time the number of revolutions is not sufficient or the engines show signs of slowing, special efforts are made to force them.

In the fire rooms the hardest work is done by the firemen, who at all hazards keep steam at the highest pressure. Each bag of coal that is opened is tallied by the government representatives, to ascertain whether an excessive amount of coal is required. Fires are usually coaled and raked alternately on a signal which sounds automatically every minute, the various furnaces being taken in rotation in order that the operation may not take place on too many at once, as that would cause a fall of the steam pressure.

At the end of a four-hour run it is known definitely whether or not the trial has been successful. The shipbuilders' representative is informed of the result of the trial by the president of the trial board, and if successful he receives the congratulations of everyone. On former vessels no further trials were required prior to delivery to the government, but in recent battleships and cuisers endurance and coal consumption trials of twenty-four hours' duration are specified. These are intended to determine the ability of the ship to steam at cruising speeds, to give assurance of the adequacy of the arrangements for supplying coal to the boilers, and in general to obtain a knowledge of the cruising capabilities. Upon the completion of all tests in connection with the trial, the government representatives are landed at a convenient port, and the vessel returns to the shipyard, to be finally completed and turned over to the government.



An Elaborately Designed Public Sun Dial.

Vertical Dial, Facing S. W., Bowdoin College, Brunswick, Me.

Sun Dial in Zoological Park, Washington, D. C.

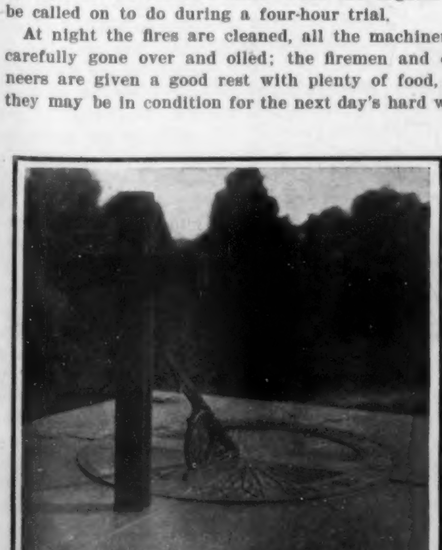
SUN DIALS: HOW THEY ARE MADE AND USED.

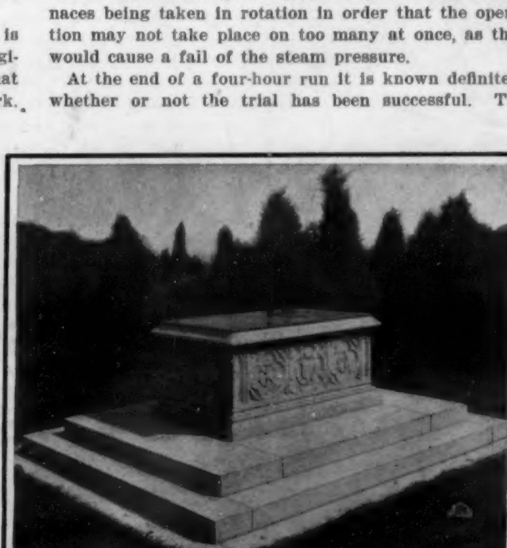
BY E. M. DOUGLAS, M. AM. SOC. C. E.

The general opinion regarding sun dials is that they are merely ornamental toys. It is the purpose of this article to show that they may be not only ornamental but extremely useful, that they are accurate timepieces for ordinary purposes, and that they can be easily made by any ordinary mechanic. For people living in the country, and for others who do not have frequent opportunities for obtaining standard time, a sun dial affords a ready means whereby clocks may be regulated, for with a dial of 10 to 15 inches in diameter, carefully made and placed, time can be determined with an error less than 5 minutes.

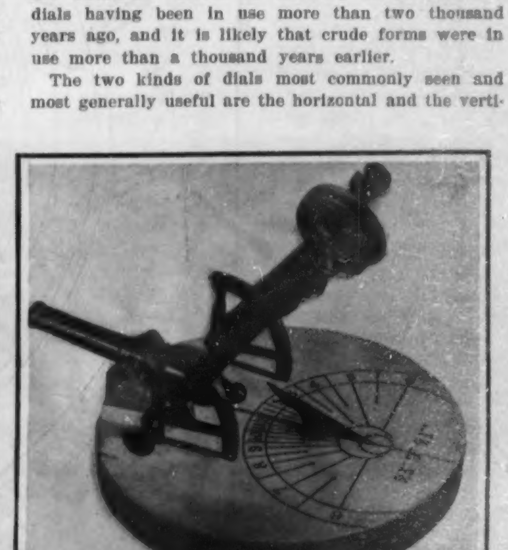
In addition to the ordinary horizontal or vertical sun dials, there are a great many other varieties possible, many of which can be classed as mere freaks. There are dials marked on the outside or inside of cylinders, of hemispheres or of cones; those for which a reflected spot of light serves as a pointer; cannon dials arranged to fire a cannon at noon; portable dials; card dials; multiple dials with a dozen or more faces all supported by one standard; inclined dials; dials in shape and size of a finger ring, etc. Before the day of cheap watches, "the art of dialing" was taught in the schools, and eminent men of science thought it not beneath their dignity to design new varieties. There are authentic records of carefully constructed sun dials having been in use more than two thousand years ago, and it is likely that crude forms were in use more than a thousand years earlier.

The two kinds of dials most commonly seen and most generally useful are the horizontal and the verti-





Two Views of a Memorial Sun Dial at Washington, D. C. The Upright Cross by the Length of Its Shadow Shows Holy Days.



A Sun Dial which at Noon Fires a Cannon, the Sun's Rays Being Focused on the Touchhole Through a Lens.

SUN DIALS: HOW THEY ARE MADE AND USED.

cal. The latter kind is usually attached to the south front of a building—sometimes on a corner. The simplest and best form is the horizontal dial, and this is the kind that will first be described.

To design a sun dial, the latitude of its location must be known, with an error which should not exceed a quarter degree. This can be ascertained in many ways; instrumentally, by measuring an altitude of the north star, using for the purpose a transit or sextant. It can be scaled off from any good large-sized map, such as those published by various branches of the government, the General Land Office, the Post Office Department, the Geological Survey, etc., or an inquiry addressed to the Washington office of the Geological Survey or the Coast Survey will doubtless bring a reply giving both the latitude and longitude of any particular place.

Before attempting to construct a dial, it is well to make a full-sized sketch of it on paper, and the accompanying tables will enable any one to do so, without other instruments than a pair of compasses and a foot rule or scale; if an inch scale divided decimally is not obtainable, the thirty-second of an inch nearest the tabular value may be used without materially affecting the results.

For a horizontal sun dial the angle at the foot of the gnomon equals the latitude of the place; this angle may be laid off as follows:

TABLE 1.—HEIGHT OF STILE IN INCHES FOR A 5-INCH BASE FOR VARIOUS LATITUDES.

Lat.	H.	Lat.	H.
Deg.		Deg.	
25	2.33	44	4.83
26	2.44	46	5.18
28	2.66	48	5.55
30	2.89	50	5.96
32	3.12	52	6.40
34	3.37	54	6.88
36	3.63	56	7.41
38	3.91	58	8.00
40	4.20	60	8.66
42	4.50		

To plot the gnomon or stile: Draw the line *a d* (Fig. 2) 5 inches in length, and at one end erect a perpendicular *d e*, the height of which is found from Table 1, direct, or by interpolation when necessary, for the given latitude. For example, latitude 38 deg. 54 min. (Washington, D. C.), the height is 5/6 of a degree greater than for 38 deg. The difference between the tabular value for 38 deg. and 40 deg. is 0.29 inch, or say 0.15 inch for 1 deg. or 0.12 for 5/6 degree, 3.91 + 0.12 = 4.03, the height required. Connect the points *a* and *e*. The angle *dae* = 38 deg. 54 min., and is the correct angle for a stile at the given latitude. The sides *ad* and *ae* may then be extended or cut short, and the back of the stile made of any shape desired. The length of the shadow line *af* should be about three-fourths the diameter of the proposed dial.

To lay out the hour circle: Draw the parallel lines *ab*, *a'b'*, representing the base of the stile in length and thickness (for ordinary metal stiles this should be from ¼ to ⅜ of an inch). With the points *a a'* as centers and with a radius of 5 inches describe semi-circles, as shown. Where these intersect the lines *ab*, *a'b'* (extended if need be) will be the XII o'clock points. A line at right angles to the base of the stile through the points *a a'* will be the VI o'clock line. Intermediate hour and half-hour lines can be located by laying off the chord distances from Table 2 for the given latitude, to the right or left from the XII o'clock points *B* and *B'*. For example, latitude 38 deg. 54 min. and IX A. M. or III P. M., the tabular value for 35 deg. is 2.57 inches, for 40 deg. it is 2.82 inches, difference 0.25 inch,

TABLE 2.—HOUR ANGLES FOR A HORIZONTAL SUN DIAL AND CHORDS IN INCHES FOR A TEN-INCH CIRCLE.

Latitude.	XII-30 XI-30	I XI	I-30 X-30	II X	II-30 IX-30	III IX	III-30 VIII-30	IIII VIII	IIII-30 VII-30	V VII	V-30 VI-30	VI
Degrees.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.
25	3 11 0.28	6 28 0.56	9 56 0.87	13 43 1.19	18 03 1.57	22 55 1.99	28 51 2.49	36 13 3.11	45 35 3.87	57 37 4.82	72 42 5.93	90 00 7.07
30	3 46 0.33	7 38 0.66	11 42 1.02	16 6 1.40	21 00 1.82	26 34 2.30	33 06 2.86	40 54 3.49	50 22 4.26	61 49 5.14	75 15 6.10	90 00 7.07
35	4 19 0.38	8 44 0.76	13 22 1.16	18 17 1.59	23 45 2.06	29 50 2.57	36 47 3.16	44 49 3.81	54 10 4.55	64 58 5.37	77 05 6.23	90 00 7.07
40	4 50 0.42	9 46 0.85	14 55 1.30	20 22 1.77	26 16 2.27	32 44 2.82	39 58 3.42	48 04 4.07	57 12 4.79	67 22 5.55	78 25 6.32	90 00 7.07
45	5 19 0.46	10 44 0.94	16 19 1.42	22 12 1.93	28 29 2.46	35 16 3.03	42 40 3.64	50 43 4.29	59 39 4.97	69 15 5.68	79 28 6.39	90 00 7.07
50	5 45 0.50	11 36 1.01	17 36 1.53	23 51 2 06	30 27 2.68	37 27 3.21	44 57 3.82	53 00 4.46	61 36 5.12	70 43 5.79	80 28 6.46	90 00 7.07
55	6 09 0.54	12 23 1.08	18 45 1.63	25 16 2.19	32 09 2.77	39 20 3.37	46 53 3.98	54 50 4 60	63 11 5.24	71 53 5.87	80 53 6.49	90 00 7.07
60	6 30 0.57	13 04 1.14	19 44 1.71	26 34 2.30	33 36 2.89	40 54 3.49	48 28 4.10	56 19 4.72	64 36 5.34	72 48 5.93	81 22 6.52	90 00 7.07

hence for 1 deg. it is 0.05 inch and for 54 min. (5/6 degree), 0.04; therefore, for 38 deg. 54 min. it will be $2.57 + 3 \times 0.05 + 0.04 = 2.76$ inches. In the same manner other hour or half-hour points may be located on the semi-circles having *a* and *a'* as centers. The V A. M. mark and the VII P. M. mark are the same distance from the VI mark as the VII A. M. and V P. M. points. Having fixed the positions for the half hours, the ¼ hour and the 5 or 10 minute marks may be computed or spaced in by eye. Lines joining each of the hour or minute marks with the center *a* or *a'* will give the hour or time lines.

If a good protractor is available, the hour and half-hour points can be found by laying off the angles taken from the table for the given latitude from the points *a* and *a'* as centers, remembering that the angle to the XII point is 0 deg. and to the VI point 90 deg. If it is desired to make the sketch on a larger or smaller scale, the radius of the semi-circles and the chord distances should be changed in the same proportion, but the angles between the base of the stile and the various hour lines must not be changed, whatever the shape of the dial plate may be. Since the hour lines are closer together near the XII points than near the VI, it is customary to extend the former to a circumference of some other circle the center *c* of which is midway between the lines *ab* and *a'b'*; the distance *ac* may be about 1/5 the diameter of the proposed dial. The outside of the dial plate may be of any fanciful design, provided that the hour points always fall on a radius or extended radius of the circle first drawn.

If tables of circular functions are available, the hour angles and chords may be computed by these formulæ. For a horizontal dial:

(1) Tan. of hour angle desired = sine of lat. × tan. (hour number × 15 deg.), the last term being the hour angle of the sun for the given time. 15 deg. for I o'clock or XI, 30 deg. for II or X, etc. For a vertical dial: The angle at the foot of the stile = 90 deg. — lat. of the place = co lat.

(2) Tan. of hour angle = cosine lat. × tan. (hour number × 15 deg.).

(3) The chord for any angle = 2 × sine of ½ the angle.

In order to have the directions for the construction of sun dials complete for all normal varieties, it will be necessary to give the formulæ for laying out dials on vertical planes which are not at right angles to the meridian; and since an example will best explain the formulæ, let it be required to construct a vertical dial on a building in lat. 38 deg. 54 min. whose front faces 40 deg. west of south. The angle 40 deg. is called the declination, and it is always to be measured from the south, either toward the east or west. There are three quantities to be determined—the angle at the foot of the gnomon or stile (*b a e*, Fig. 2), the position of the base of the stile (called the sub-stile) among the hour lines, and the angular distance on the plane between the substile and each hour line. A slight consideration of the

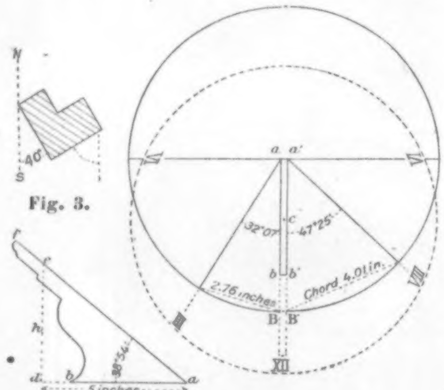
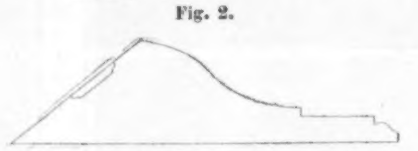


Fig. 3.

Fig. 2.



Detail: Gnomon of Fig. 1.

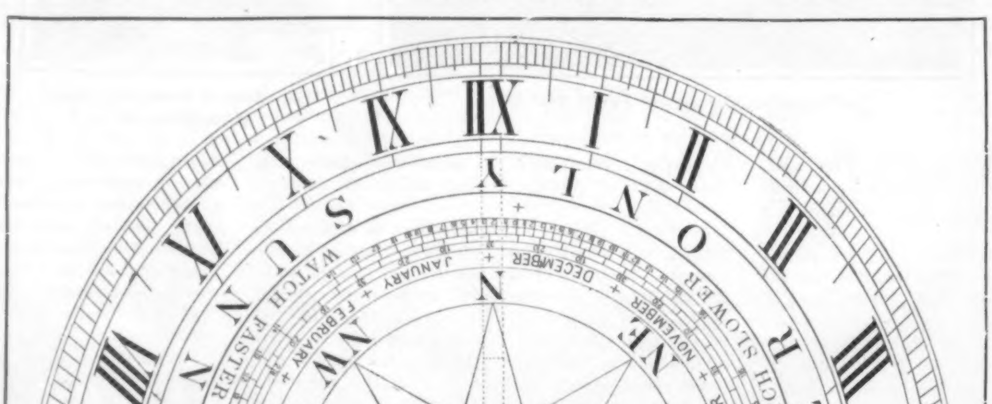


Fig. 1.—Dial Plate of Sun Dial in Washington Zoological Park.

SUN DIALS: HOW THEY ARE MADE AND USED.

conditions will make it evident that for a plane facing eastward the position of the stile will be among the morning hours and for one facing westward among the afternoon hours, for the stile could not be placed in any other position where its sloping side would still point to the north pole; also that for all dials the XII o'clock line will lie in a vertical north and south plane.

To find the angle at the foot of stile, being the height of stile above the plane:

(4) Sine of required angle = cos. lat. × cos. declination.

For the given lat. 38 deg. 54 min., and the declination 40 deg.

Log. cos. lat. = 9.89112
Log. cos. dec. = 9.88425

9.77537 = log. sine 36 deg. 36 min.

Difference of longitude, or equatorial value of declination, being the equatorial value of the angle between sub-stile and the XII o'clock hour line.

(5) Cot. angle required = sine lat. × cot. dec.

Log. sin. lat. = 9.79793
Log. cot. dec. = 0.07619

9.87412 = log. cot. 53 deg. 11 min.

Angular distance on the given plane between sub-stile and the XII o'clock line, being the angle from (5) reduced to the plane of the dial.

(6) Tan. angle required = sine angle from (4) × tan. angle from (5).

Log. sine (4) 36 deg. 36 min. = 9.77537
Log. tan. (5) 53 deg. 11 min. = 0.12578

9.90115 = log. tan. 38° 32'.

The angle to any other even hour may be found by subtracting or adding multiples of 15 deg. to the longitude value from (5) and using the resulting angles in equation (6) in place of the angle from (5). The sub-stile was found from (5) to be 53 deg. 11 min. from the XII o'clock line. This arc reduced to hours by dividing by 15 gives three full hours with 8 deg. 11 min. remainder (53 deg. 11 min. ÷ (3 × 15 = 45) = 8 deg. 11 min.). This fixes its position between the III and IIII o'clock lines, as the plane faces westward.

Subtract 15 deg. from 53 deg. 11 min. and substitute the tan. of the remainder (38 deg. 11 min.) for tan. from (5) in formula (6).

Log. sine (4) = 9.77537
Log. tan. 38 deg. 11 min. = 9.89567

9.67104 = log. tan. 25 deg. 07 min. = the angle between sub-stile and the I o'clock line. In like manner by continued subtraction of 15 deg., other afternoon hour lines may be found. The equatorial angle for III will be 8 deg. 11 min.; for IIII it will be 60 deg. — 53 deg. 11 min. = 6 deg. 49 min. By adding 15 deg. or multiples of it to 53 deg. 11 min. the morning hours may be computed. Fractions of hours may be determined in the same manner. If it be desired to plot the hour lines by chords, they may be found for the various angles by (3). If the stile has an appreciable thickness, the hour lines on either side must radiate from centers whose distance apart equals its thickness.

Numerous methods have been devised for finding the position of the hour lines graphically, but all require more skill in drafting than the methods here given. Some of the graphic methods are described in Ferguson's lectures on astronomy (1840); the "Book of Sun Dials," by Mrs. Alfred Gatty, 1900; the "Cyclopædia Americana," subject Dialing; or in the quaint old book on dialing by William Leybourn, published in England in 1682. In the latter book sun dials are classified into fifteen general varieties, and instructions are given for laying out dials of a great many kinds. The descriptions although somewhat difficult to understand are in considerable detail for both graphic and trigonometric methods; from the principles as set forth in this book nearly all the foregoing formulæ are derived.

So much for the designing; the construction will necessarily depend on the abilities and facilities of the builder.

The simplest and easiest dial to construct will be of wood, probably square in outline, having the hour marks painted or outlined with small nails. Such a simple affair, the product of a half hour's work by the writer, fastened to a front fence proved a source of daily interest to passers-by for several years. A more substantial dial may be built by an amateur, of small bowlders laid up in cement, with a cement top and brass stile, the hour marks cut into the cement with a knife as it hardens. A square bar of brass or bronze, suitably bent for setting in the cement, can be used for the stile if nothing better is available. Other material suggested which may be used for the base are bronze, aluminium, brass, marble, slate, or some other stone. The hour marks for stone dials may be cut in, or made of pieces of sheet metal cut to shape and riveted on. The stile is sometimes made of stone also, but is much better if made of cast bronze or brass.

A more elaborate design is that shown in an illustration and in outline in Fig. 1, which is from a very fine sun dial in the Zoological Park at Washington, D. C. Such as this can be made by a skilled workman only, but as its design will doubtless offer useful suggestions for others less elaborate, a brief description may be of interest.

Fig. 1 shows the general design of the dial plate and stile. The two dotted parallel lines between the *S* and *N* represent the base of the stile, which has parallel sides and is ⅜ inch thick. The stile is attached to the plate by screws from underneath, extra firmness being given by a circular hub at the center; the plate is of bronze ⅝ inch thick and 18 inches in diameter, with hand-engraved letters and figures; the motto is in Latin. The translation of the motto is given in Fig. 1. The Watch Faster Watch Slower diagram is Table 3 in graphic form, with a graduation for each day of the year. The blank space near south end contains scroll work and the name of the English maker; the dial rests on a cut-stone pedestal. The open space near south part of the dial is taken up in another Washington sun dial by an engraved copy of a table somewhat similar to Table 3. This for general use will probably be better understood than the graduated circle.

TABLE 3.—CORRECTIONS IN MINUTES TO CHANGE SUN TIME TO LOCAL MEAN TIME. ADD THOSE MARKED +, SUBTRACT THOSE MARKED —, FROM SUN DIAL TIME.

Day of Month.	1	5	10	15	20	25	30
January	+ 3	+ 5	+ 7	+ 9	+11	+12	+13
February	+14	+14	+14	+14	+14	+13	
March	+13	+12	+11	+ 9	+ 8	+ 6	+ 5
April	+ 4	+ 3	+ 2	+ 0	— 1	— 2	— 3
May	— 3	— 3	— 4	— 4	— 4	— 3	— 3
June	— 3	— 2	— 1	+ 0	+ 1	+ 2	+ 3
July	+ 3	+ 4	+ 5	+ 6	+ 6	+ 6	+ 6
August	+ 6	+ 6	+ 5	+ 4	+ 3	+ 2	+ 1
September	+ 0	— 1	— 3	— 5	— 6	— 8	—10
October	—10	—11	—13	—14	—15	—16	—16
November	—16	—16	—16	—15	—14	—13	—11
December	—11	—10	— 7	— 5	— 3	— 0	+ 2

When placing a horizontal or vertical dial in position, considerable care should be taken to make the hour circle truly horizontal or vertical as the case may be, and to place the plane of the gnomon at right angles to the dial face. The XII o'clock line for all dials must lie in a vertical north and south plane, and for all dials the sloping side of the stile (the shadow line) must point as nearly as possible toward the north pole. An ordinary carpenter's level is sufficiently accurate for plumbing the dial plate, and if the magnetic declination be known, a compass needle will enable one to properly orient the stile.

When the north star is visible from the point selected for the dial, suspend a plumb line 8 or 10 feet to the north, and in line between the selected point and the north star when on the meridian, i. e., when the double star in handle of the Dipper is vertically over or under it; then fix the sloping side of the stile so as to point to the plumb line, and it will be in proper position.

A simpler but less accurate method is this: Orient the dial as nearly as may be by eye. Compare the dial readings and the time by a good clock set at standard time at say 9 A. M., noon, and 3 P. M. The dial time and clock time should agree after the latter has been corrected for equation of time (Table 3) and for difference between standard and local time. If they do not agree, change the position of the dial and compare again another day.

It is well known that sun time and clock time (generally called mean time) seldom agree; the difference between them is more than 16 minutes on November 1 and nearly 14 minutes on February 1. In November the clock is slower, while in February it is the sun that is slow. Four times a year, namely, April 16, June 15, September 2, and December 25, the difference between mean and apparent time is zero; on those dates the readings on a sun dial need no correction.

Table 3 gives the corrections for selected dates; for others not given the correction may be found by interpolation with an error not exceeding a minute at any time. The corrections marked + correspond with those in Fig. 1 marked Watch Faster. It is advisable to have this table or a modified form of it engraved on the face of every sun dial that makes a pretense to accuracy.

To reduce dial readings to standard (railroad) time still another correction must be made, which is constant for each given locality. Standard time in the United States is the correct time for longitudes 75 deg., 90 deg., 105 deg., or 120 deg. west from Greenwich, corresponding with the time in use in New York, Chicago, Denver, and San Francisco respectively. The distance in degrees of longitude that the dial is east or west of the nearest of the meridians must be ascertained; divide this distance in degrees, reduced to minutes and seconds, by 15, and the quotient will be the correction in minutes and seconds of time. If the dial be west of the meridian chosen, then the watch is faster. Table 3 may if desired include this correction, by making each tabular value faster by the amount of the correction when the dial is west of the standard meridian and the opposite for dial east. For example, Washington, D. C., is longitude 77 deg., hence standard time is 2 deg. (or 120 min.) ÷ 15 = 8 minutes faster than mean time for all dates.

Another method of allowing for this correction is to shift all the hour marks on the dial plate by an amount equal to the difference between standard and local time. Thus for Washington each of the hour marks would be moved forward an amount equal to nearly two of the 5-minute spaces. The XII o'clock mark would then fall slightly to the west of the normal position, and would be out of the vertical plane of the dial.

Sun dials are sometimes used as ornamental features on public buildings, and if public officers realized the interest which such features arouse, there would be many more thus used than there are now. For public parks sun dials that will be both useful and instructive can be designed. These may show the time at each hour or minute for distant cities, or the direction and distances to those near by; the signs of the Zodiac; the latitude, longitude, and elevation above sea level, etc. One beautiful dial in Washington has besides the hour marks an erect cross, which by its shadows at different times of the year indicates closely the times of the various feast or fast days.

It is believed that no single object that can be secured at small cost will afford the lasting interest of a sun dial; and during the long winter evenings, what pleasanter pastime can an amateur mechanic find than in constructing such a counter of time, that may be a source of pleasure to himself and friends for years that follow.

All well-designed sun dials have mottoes of one kind or another, and the builder may by adding to his work one of suitable selection, give a lasting expression of good will to others; of the many such selections none seems happier than:

"Let others tell of storms and showers,
I'll only count your sunny hours."

Official Meteorological Summary, New York, N. Y., May, 1908.

Atmospheric pressure: Highest, 30.27; lowest, 29.45; mean, 29.94. Temperature: Highest, 86; date, 27th; lowest, 40; date, 3d; mean of warmest day, 78; date, 27th; coolest day, 48; date, 7th; mean of maximum for the month, 69.1; mean of minimum, 53.5; absolute mean, 61.3; normal, 59.8; excess compared with mean of 38 years, +1.5. Warmest mean temperature of May, 65, in 1880. Coldest mean, 54, in 1882. Absolute maximum and minimum for this month for 38 years, 95 and 34. Average daily excess since January 1, +1.3. Precipitation: 9.10; greatest in 24 hours, 4.17; date, 7th and 8th; average of this month for 38 years, 3.33. Excess, +5.77. Accumulated excess since January 1, +4.03. Previous greatest May precipitation, 7.01, in 1901; least, 0.33, in 1903. Wind: Prevailing direction, N.E.; total movement, 9,353 miles; average hourly velocity, 12.6 miles; maximum velocity, 50 miles per hour. Weather: Clear days, 7; partly cloudy, 10; cloudy, 14; on which 0.01 inch or more of precipitation occurred, 12. Hail, 2d; fog, dense, 20th, 22d, 23d, 24th, 26th, 29th; thunderstorms, 14th, 22d, 26th. Mean temperature of the past spring, 51.08; normal, 48.7. Precipitation of the past spring, 13.07; normal, 10.69.

Automobiles for Viticulture.

Automobiles for agricultural purposes are attracting considerable attention in Europe at the present time. So widespread has interest in this subject become, that there will be held at Palermo, Italy, this fall a competition for motor machinery for viticulture. The best machine of this class will be awarded a diploma and a $2,000 cash prize, and two such machines will be purchased. A second prize of $600 and a gold medal will also be given. Applications must be sent to the Minister of Agriculture at Rome before August 15, and the machines must be at Palermo by October 16.

The German Empire has nearly 35,000,000 acres of forest, of which 31.9 per cent belongs to the State, 1.8 per cent to the Crown, 16.1 per cent to communities, 46.5 per cent to private persons, 1.6 per cent to corporations, and the remainder to institutions and associations. There is a little over three-fifths of an acre of forest for each citizen, and though 53 cubic feet of wood to the acre is produced in a year, wood imports have increasingly exceeded wood exports for over forty years, and 300,000,000 cubic feet, valued at $30,000,000, or over one-sixth of the home consumption, is now imported each year. Germany's drains on foreign countries are in the following order: Austria-Hungary, 19,750,000 tons; Russia and Finland, 18,000,000 tons; Sweden, 508,000 tons; the United States, 36,000 tons; Norway, 49,000 tons.

TOWING TANK AT THE UNIVERSITY OF MICHIGAN.

BY DAY ALLEN WILLEY.

One of the most interesting departments of the University of Michigan is that devoted to marine engineering and seamanship. As the Great Lakes offer a vocation to young men qualified as shipbuilders and navigators, the department in question embraces a course which not only includes theory but equipment, by which the students are given a series of valuable object lessons in the acquirement of their chosen vocation. The department includes an experimental ship tank and apparatus, for the purpose of showing clearly the proper lines of a vessel which is intended to attain a certain maximum speed at the expenditure of a given horse-power. Consequently, the tank, which was designed and constructed under the supervision of Prof. Herbert C. Sailer of the Department of Marine Engineering, is utilized largely to perform experiments upon various forms of ship models, and to determine the resistance to motion of these forms at all speeds.

The tank itself is 300 feet long, 22 feet wide, and 10 feet deep. This length is the least that can be used in order to allow time for starting, obtaining uniform speed, and stopping. The breadth and depth are necessary, so that the effect of the sides and bottom will not have any material influence upon the resistance of the model. Spanning the tank is a traveling truck, which runs on rails on either side of the tank. This truck is driven by a 25-horsepower motor, which can be so regulated as to give speeds to the truck varying from about 10 feet per minute to 800 feet per minute. It is essential that the speed of the truck should be uniform at any speed between these limits, so that the resistance of the model may be determined accurately at any speed. The models are run at a series of different speeds and thus a curve of resistance in terms of speed obtained. In order that the speed may be uniform and not affected by changes of load in the power house, a special motor generator set has been installed upon the truck. The current from the power house is taken to this set by trolleys, and converted as required. The connections are such that if any fluctuation takes place upon the line, this is compensated for in the installation, and the speed of the driving motor remains unaffected. The speed is regulated by a controller with five main stops, and between each stop an auxiliary rheostat with fifty stops may be thrown in, so that between the limits given above, two hundred and fifty different speeds may be obtained. The driving motor is also fitted with a high and low speed gear and switchboard, and connections mounted on the truck.

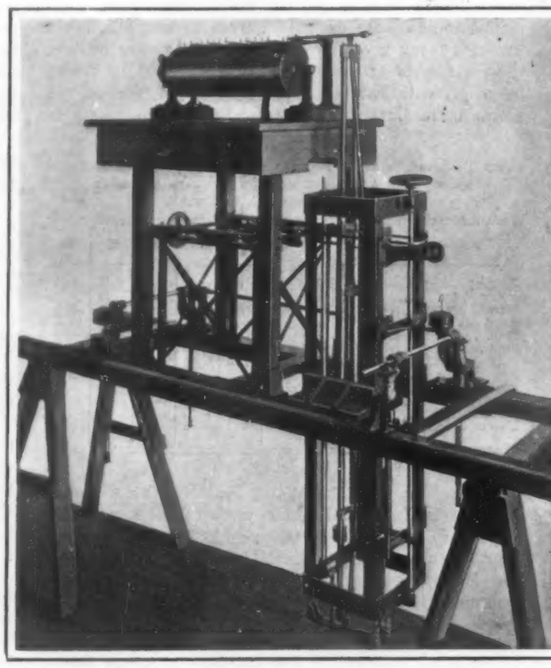
On the forward end of the truck is the dynamometer, through which the models are towed. This consists essentially of a vertical bar mounted on emery supports. Instead of the usual knife edge a thin piece of spring steel is used, with about one-sixteenth of an inch between the supports. Parallel rods are introduced, so that both the pull upon the spring and model are in a horizontal direction. The model is attached to the lower end of the dynamometer, and its resistance taken up by the spring. The amount of extension of the spring is registered upon a revolving drum, which is driven from the main shaft of the truck. Upon this drum are two electric pens, one of which is connected to a clock and registers every half-second, the other is connected with contacts along the side of the tank and registers every ten feet. Thus the time and distance and hence speed are determined. Two other pens register the amount that the model rises or falls at the bow or stern when moving at different speeds.

The substance of which the models are made is paraffin wax with a mixture of beeswax. This material may be melted at a low temperature and cast without difficulty; it is also easily cut, planed, or scraped. It furnishes a uniform surface for all models, and when a model is not required for further experimenting, it may be broken up and used for another of a different type. Before casting a model a mold is first prepared. This mold is made in ordinary modeling clay. Sections of the vessel at different points in its length are first cut out of wood, about one-quarter of an inch larger than the actual size required. These are placed in the bed, and the clay molded and kneaded in until it conforms to the proper shape. As the models have to be cast hollow, a core is next made. The forms as above are cut out so as to allow a thickness of paraffin wax of about one and one-half inches. These forms are then connected by thin wooden strips and covered with canvas, so that the core forms as it were a canvas canoe, which is suspended inside the clay mold. The paraffin wax is then melted in a tank provided with a steam coil, and the mold poured. While cooling, considerable contraction occurs, so that small quantities of melted wax must be added continually. While the wax is being poured, water is introduced into the inside of the core, in order to overcome its tendency to float and also to aid in cooling. When cooled the core is withdrawn, and the model floated from its bed by introducing water between the walls of the mold and the model. The model is now in its rough state, and ready to be cut to the correct form. It is next placed in the cutting machine. This consists primarily of two tables, on one of which is placed the model, and on the other the drawing of the lines which it is desired to reproduce. These two tables move together and are driven by a motor; the motion of the driving table is, however, usually about one-half as fast as that of the model table, but this ratio can be varied by introducing change gears. The object of this is so that the drawings do not have to be made unnecessarily large. In the middle of the machine is a cross piece, upon which are two traveling heads, which move together inward or outward, and are operated by a right- and left-handed screw. These heads carry two vertical hollow spindles, which have a screw thread cut on the outside. By means of a worm gear these may be raised or lowered to any desired extent, the amount of the vertical movement being measured by a scale and vernier upon one of them. Inside each spindle is a shaft, which is driven by a vertical motor on the top, and to the bottom of which is attached a two-bladed cutter. As the in and out motion of the cutters must correspond with the breadth upon the drawing at various points, the motion of the cutters is transferred to the drawing by means of a pantograph. One end of the pantograph is attached to one of the cutters, and the other movable or center part to a bar, which is carried over to the drawing, and on the end of which is a pointer. If for example the drawing is one-half the size of the model, the arms of the pantograph are set in this ratio. When, therefore, the screw which operates the heads carrying the cutters is revolved, the cutters move in or out a certain amount, and the pointer on the drawing one-half this amount. As, however, the points of the cutters describe circles, the pointer is also a circle, but of one-half the radius of the cutter circle.

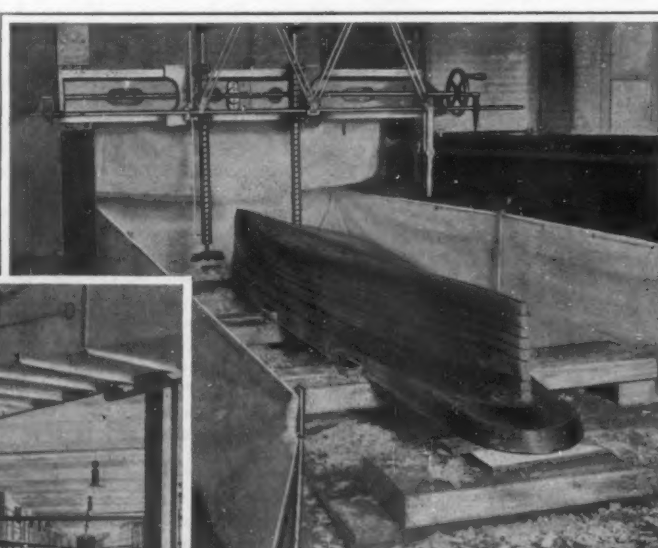
From one drawing it is thus possible to cut any number of models of the same form, but varying in ratio of beam or draft to length. If a broader or narrower model is desired, all that has to be done is to alter the fulcrum of the pantograph, and the relative motions of the cutter and pointer on the drawing are altered accordingly. If it is desired to change the ratio of draft to length, the amount by which the vertical motion of the cutters is changed for each waterline may be correspondingly increased or decreased.

When the model is ready to be finished, it is placed upside down upon its table, carefully centered and clamped down; the drawing is also placed upon its table, and the center line adjusted. The cutters are now run up to the bottom of the model, and moved in so that they nearly touch. They are then put into motion, as is also the table, and the base line or top of keel cut from one end to the other. The cutters are now lowered to a depth corresponding to the first waterline as shown on the drawing. The cutting is usually started from amidships, and worked both ways toward the ends. The operator now runs in the cutters until the pointer is exactly upon the line required, and starts the two tables moving. By operating the handle on the right- and left-handed screw, the cutters are gradually brought together and their motion transferred to the pointer. He must so regulate this motion that the pointer remains tangent to the line he desires to follow, while the drawing moves along. In this way the cutters are made to follow exactly any desired line. When one line has been cut they are lowered to the next, and so on until all the lines have been cut.

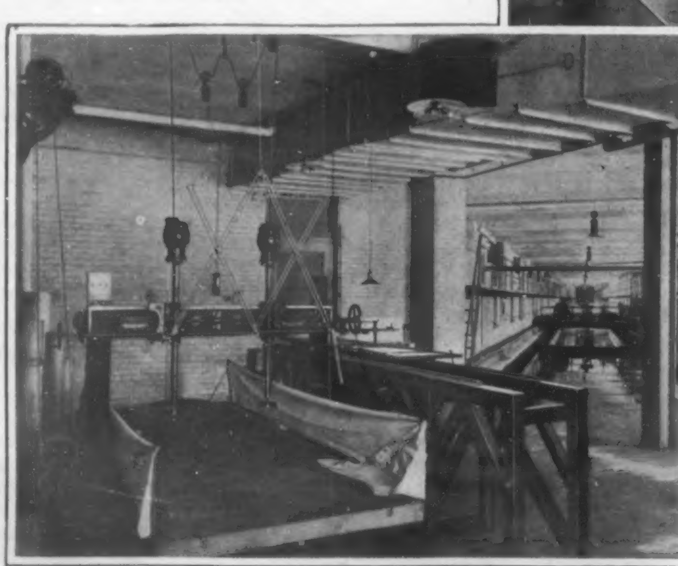
When this part of the work is finished, the model has a series of longitudinal grooves as shown in the photograph, which represent the correct shape of the various waterlines. It is now taken to the finishing table, and the superfluous material between the grooves removed until the grooves have almost disappeared. It



Machine for Cutting Models to Their Correct Proportions.



Machine Cutting a Wax Model. Grooves Show Correct Shape of Waterlines.



General View of Model-Cutting Machine and Experimental Tank.

TOWING TANK AT THE UNIVERSITY OF MICHIGAN.

is finally finished with a scraper, and when the grooves have disappeared and the surface is fair, it receives a final burnishing. The position of the desired load or any other waterline is now marked upon it at different points, and check measurements are taken to see if the model is correct to the drawings. It is then carefully weighed and placed in the tank. The amount of ballast, which consists of shot bags, necessary to bring the model down to the desired load line, is also calculated and weighed out and put in place.

A MACHINE FOR BURNING WEEDS ALONG RAILROADS.

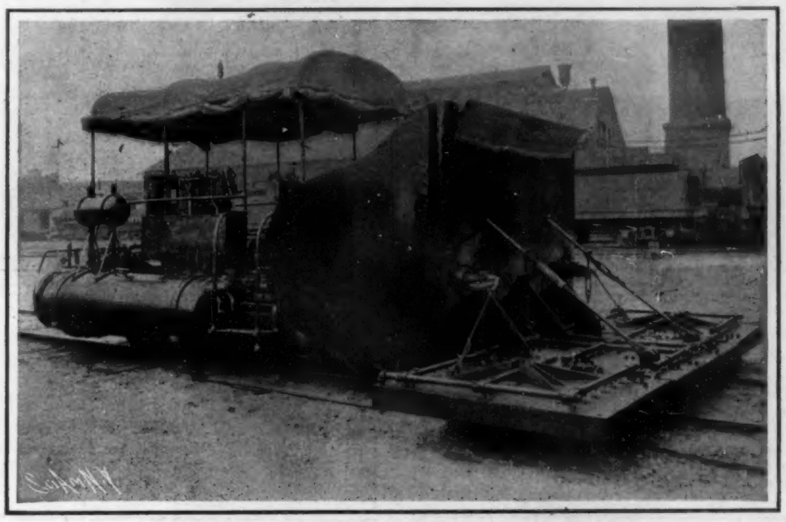
BY J. MAYNE BALTIMORE.

The problem of keeping railroad lines free from weeds during the spring and summer months has always been a difficult one in the West. More than a year ago the operating officials of the Union Pacific, finding that weeds proved to be a very expensive annoyance, set about to produce some economical means of destroying them. Many suggestions were offered, such as that of cutting the weeds off by machinery, and sprinkling the roadbed with a saturated solution of salt and water. After much experimenting the weed burner illustrated herewith was evolved.

This machine consists of a car propelled by a gasoline engine. The engine is also used to force air and gasoline to a set of burners at the back of the car. The gasoline is burned under forced draft close to the ground, and develops sufficient heat to kill the weeds. The burners are arranged in three sections, the center section extending a little beyond the rail, and the side sections being hinged to the center section, so that they may be lifted out of the way of obstructions, such as cattle guards and the like, along the right of way. The side wings can also be set at an angle, in order to get the burners close to the ground on any kind of grading. With these sections fully extended, a strip 12 feet wide is burned, or about 3 feet on each side of the rail.

The propelling mechanism is provided with a two-speed gear; the slow speed, used while burning the weeds, drives the machine at from 3 to 4 miles per hour, while the high speed, used in going to and from the work, runs the machine at a speed of from 12 to 15 miles per hour. The car carries a number of tanks of gasoline, in which there is a supply sufficient for a day's run on the road.

It has been found advisable in practice to make the first burning early in the year, when the weeds have reached a height of from 6 to 8 inches. Then going over it again a few weeks later, when the weeds have dried somewhat, they are entirely destroyed, root and branch. It is sometimes necessary to repeat the performance three months later. The machine is capable of burning some 20 to 25 miles a day. Three men are required to handle the car, which is run under orders as a regular train. When the weeds are cut by hand, it requires approximately 16 men to cut one mile of track per day, hence the machine does the total work of about 300 men.



A MACHINE FOR DESTROYING WEEDS ALONG RAILROADS.

Although electricity generated by hydraulic power is daily increasing as the motive power in Spain, says a consular report, the increase of mechanical—steam or gas—power as an auxiliary is as great or greater than before. Owing to the climatic conditions of Spain, water power varies greatly in summer and winter, and there is a choice of evils—either of seeing a great deal of power run to waste in winter or of using that power in winter and supplementing it in summer by gas or steam.

REMOVING THE GRAND CENTRAL TRAIN SHED, NEW YORK.

It will be remembered that one of the most important features of the electrification of the suburban zone of the New York Central & Hudson River Railroad Company's system in the vicinity of New York is the removal of the present Grand Central station, and its reconstruction on a much larger and more convenient plan.

In planning this work, it was recognized that it would have to be carried through without any interference with the present passenger traffic. The original plan was to excavate the easterly portion of the yard, build the new east side station, and transfer the traffic thereto while the work of removing the old train shed was being carried on. The rapid increase in traffic, however, and the rate of progress of the excavation, necessitated a change in this plan; and it was decided in the autumn of 1907 to remove the shed, while the through passenger trains of the New York Central and the through and local trains of the New Haven continued to use the old station.

Now, since the train shed is about 600 feet in length, with a span of 200 feet 1 inch, and its clear height from platform to under side of arches is 85 feet, it will be understood that the removal of this great structure, without any interference with the incoming and outgoing trains and their passengers, constitutes a task of no little difficulty. The weight of the train shed being carried on trussed arches, which, when cut apart for taking down, must at once lose their stability, it became necessary to provide some system of support which could carry the weight of the arches during their removal.

To accomplish this and protect the trains and passengers beneath from falling material, the engineers designed a huge timber traveler, with its outline conforming to the curve of the arch of the train shed spanning all of the station platforms. It is provided with heavy floors extending the entire width of the shed. The traveler, which, when it is carrying the weight of two of the train-shed trusses, weighs about 1,000 tons, stands upon five longitudinal bents located on about the center lines of the five intermediate platforms. Each bent consisting of four legs properly braced rests upon 12 x 14 longitudinal timbers, to which are bolted under each leg two-wheeled, double-flange trolleys, which run upon longitudinal 100-pound rails laid upon a system of heavy transverse ties covering the whole width of each platform. The traveler is 65 feet long by 200 feet wide and contains 370,000 feet of lumber, 65 tons of bolts and washers, and 33 tons of plates and castings. It is provided with six platforms, three on each side, upon each of which is a derrick for handling the material as it is dismantled. The inner face of the traveler is boarded over, thus forming a false end for the train shed as the traveler moves forward in its work of dismantling.

The operations are as follows: As soon as the traveler has moved to a new position and been blocked up, two of the train-shed trusses are blocked on top of it. The corrugated iron roofing, glass, skylights, and purlins, are first removed. The northerly truss is then cut into eight sections by knocking off rivet-heads at the joints, and by the use of hack saws. These sections are then lifted by the derricks on to the traveler platforms. All of this work is done during the daytime. During the following night, gangs of men load the material from the platforms on to cars placed on the passenger tracks below the traveler. When the two trusses have been removed, the traveler is pushed forward another 40 feet into the shed by means of two 15-ton jacks on each platform. The time necessary for moving the traveler each 40 feet is about three hours.

As fast as the train shed is removed, low wooden canopies covering the platforms are constructed, this new work following up the progress of the traveler as closely as possible, so as to provide unbroken shelter for the passengers. The accompanying photograph, taken when the work was about half completed, shows the traveler and the platform canopies with great clearness.

An interesting feature in this photograph is the work of excavating the easterly portion of the yard, which is visible in the left-hand corner of the engraving. It was here that the annex to the train shed formerly stood. As fast as the rate of excavation will allow, new tracks are laid and additional trains are moved over from the old high-level station to the new low-level east station. This process will be continued until the level of the tracks in the present train shed has been lowered some 35 to 40 feet. Following closely upon the excavation, the two decks of the new station will be constructed, and above them will be built the new and very commodious terminal building, illustrations of which have been already given in the SCIENTIFIC AMERICAN.

The iron trusses of 200-foot span are being removed piecemeal by means of the huge 800-ton movable derrick, seen in the end of the shed. The derrick travels on rails laid down the center of the platforms.

REMOVAL OF THE 600-FOOT TRAIN SHED OF THE GRAND CENTRAL STATION, NEW YORK.

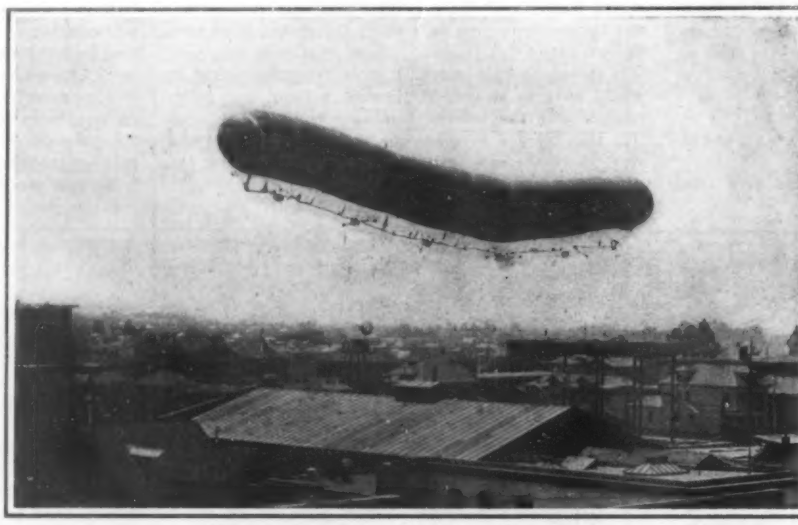
Not only is the government doing valuable work in the preservation and growth of forests, but private owners are also taking hold of this work. The idea of protecting logged off lands and holding them for a second growth of timber is growing and there is no reason to think that States will not take this matter up and hold large areas of these lands for their future timber. Men who were brought up in the eastern States have gone back to them recently after a long absence, and are surprised to see the wonderful amount of timber growing everywhere. Coal has become such a prominent factor in heating that the demand for wood as fuel does not seem to keep pace with the growth of wood suitable for that purpose.

A GIGANTIC AIRSHIP DISASTER.

BY OUR SAN FRANCISCO CORRESPONDENT.

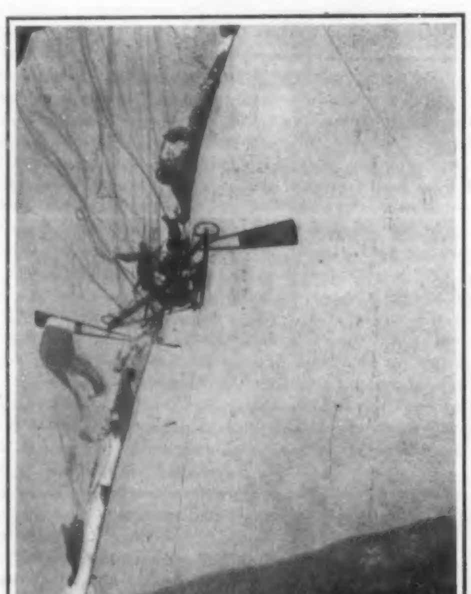
The airship shown in the accompanying illustrations, which was designed and built by John A. Morrell, came to a sudden and disastrous end during its first test, which was held Saturday, May 23, at Berkeley, Cal. The airship, as can be seen, consisted of a large pointed balloon 485 feet long and 34 feet in diameter. The envelope contained from 400,000 to 500,000 cubic feet of gas, and below it at intervals were supported, by means of netting and stout ropes, six 4-cylinder, 40-horse-power automobile motors, each of which was connected by belts to two propellers, one on either side. The netting which surrounded the envelope was joined together beneath and carried a canvas mattress, upon which the aeronauts stood and by means of which they could pass from one power plant to the other. The balloon was filled with illuminating gas, which gave it a lifting capacity of from 8 to 10 tons. It was, therefore, quite the largest airship that has ever been built in America, and was even larger than the German dirigible of Count von Zeppelin. Upon the first test of this airship, it was released from its moorings and allowed to ascend to a height of 200 or 300 feet. The ascent was accompanied by the cheers of several thousand spectators. On account of the nose of the balloon being tardily released, the envelope was given an upward inclination toward the rear of as much as 45 deg., the result being that the gas rushed to this end with great impetus and struck against the top at that point with a pressure of about 30 pounds per square foot, or 30 times more than would be considered safe with a well-constructed balloon. The oiled cloth, of which the envelope was constructed, could not withstand the pressure, and it burst, whereupon the machine fell rapidly to the ground, carrying with it its nineteen passengers, who were tangled in a mass of broken machinery, flapping cloth, and network. The passengers on board the ill-fated craft consisted of the inventor, eight engineers, five valve tenders, two photographers and their assistants, and an aeronaut. Strangely enough, none was killed, six escaping uninjured and several others with slight injuries. The inventor had his right leg broken, but only three men suffered injuries that may result in death. The inventor of the airship came from Chicago to San Francisco last year, and built a vessel, the balloon of which was too small to lift the engines and the netting. It got loose before the crew of twelve men boarded it, rose from 100 to 200 feet in the air, and reached Burlingame in San Mateo County, about twenty miles south of San Francisco, where it rested. Then Morrell organized the National Airship Company, incorporated under the laws of South Dakota, and put forth a prospectus in which it was stated that an airship one-quarter of a mile long was under construction and would make regular trips between San Francisco and New York city. The chairs and bedsteads were to be made of hollow aluminium tubes, the former weighing 17 ounces and the latter 27 ounces, and the mattresses were to be inflated with a very light gas of a secret nature.

The airship wrecked on May 23 was under construction for some months in the company's shops in San Francisco, and was then taken across San Francisco Bay to Berkeley. George H. Loose, who has had considerable experience in building airships and aeroplanes, had charge of the construction, and was to have been first officer of the craft, but he refused to make the ascent because Morrell disregarded his advice in the work. Loose says that the machine was unsafe; the ends were not braced, so that, if the envelope was filled with enough gas to keep it rigid, the emergency valves would open, and if these were tightened, the envelope was liable to burst. Morrell, when asked to give his account of the disaster, said that when the airship left the ground and the rear end began to rise higher than the bow, he gave orders to let go the holding ropes below, so that the equilibrium might be restored. The shouting of the spectators drowned his voice, so that his orders could not be heard; the gas rushed to the rear end, and the bag, unable to withstand the pressure, burst. Members of the crew of the vessel say that the envelope was made of flimsy muslin, unable to resist even ordinary pressure, and that the forward end of the bag was insufficiently filled with gas. Morrell says that, though he feels his general theory of aerial navigation is correct, the ascent was forced on him by the stockholders in the company before he



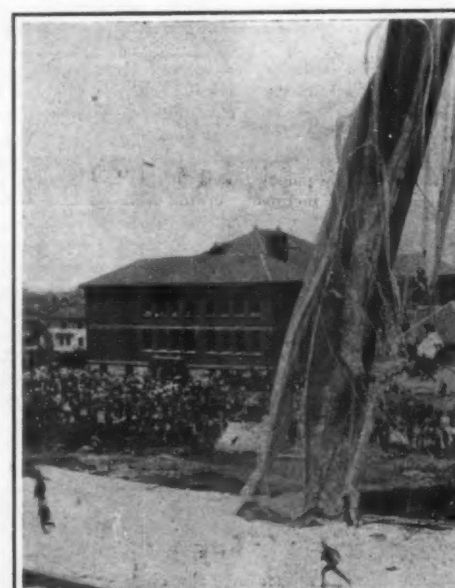
The Airship in the Air Before Its Collapse.

Note the curvature of the balloon owing to no rigid framework.



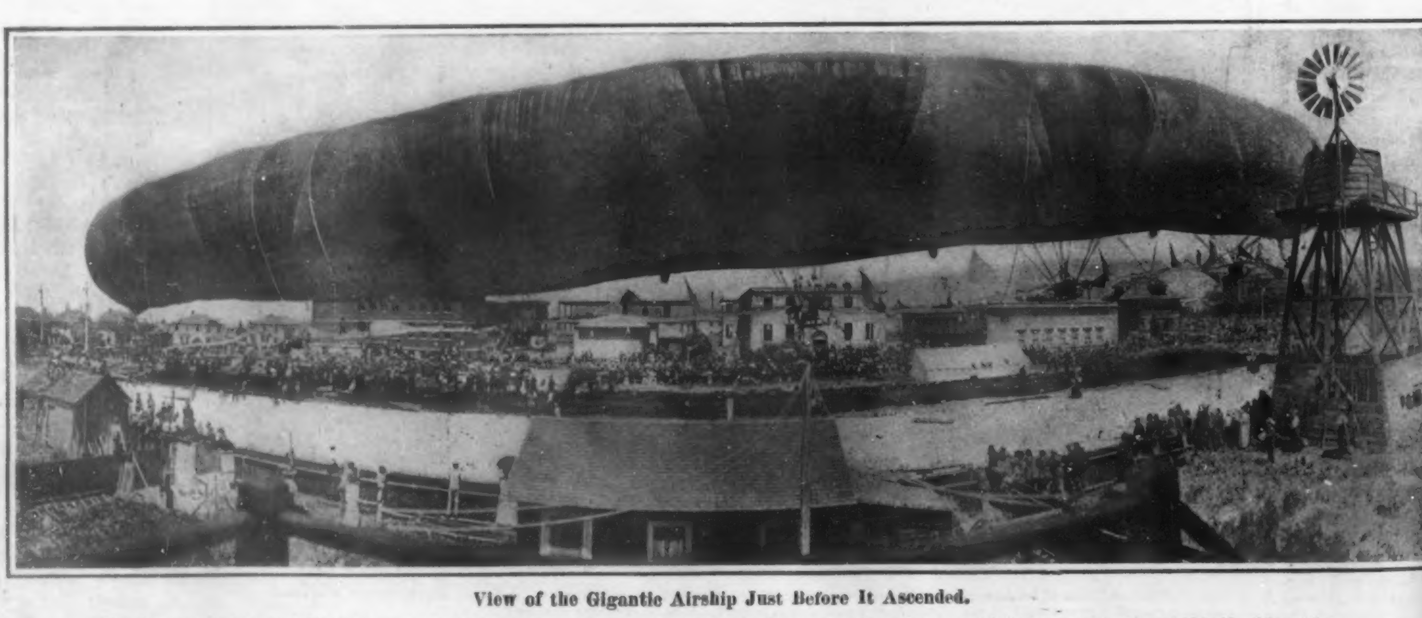
One of the Power Plants of the Falling Airship.

The men are seen clinging to the netting, the mattress in the bottom of which has assumed a nearly vertical position.



The Collapsed Balloon Striking the Earth.

One of the engines is seen dangling beside the deflated envelope.



View of the Gigantic Airship Just Before It Ascended.

The six power plants suspended by ropes are clearly visible, as well as the men located at different points on the mattress that connected the power plants and was laid inside of the netting.

THE CALIFORNIA AIRSHIP DISASTER.

had thoroughly worked out certain principles. Notwithstanding the almost total loss of a machine that cost about $40,000, Morrell says that the company is ready to proceed with the construction of another airship, 750 feet long, 40 feet in diameter, and equipped with eight gasoline engines, operating sixteen propellers and developing nearly 350 horse-power. The new craft will be capable (according to the promoters) of a speed of a hundred miles an hour. A platform will be substituted for the canvas and netting cage on which the crew rode on May 23. Light silk will be used for the inside bag, and heavy silk interwoven with "flexible aluminium" for the outside bag. Compartments in the balloon will prevent a repetition of the disaster that attended the ascent on May 23. There will be more than a hundred of these, and many of them would have to break before the buoyancy or equilibrium of the vessel would be affected.

THE BRITISH CHALLENGER FOR THE HARMSWORTH MOTOR-BOAT TROPHY.—A 400-HORSE-POWER RACING CRAFT.

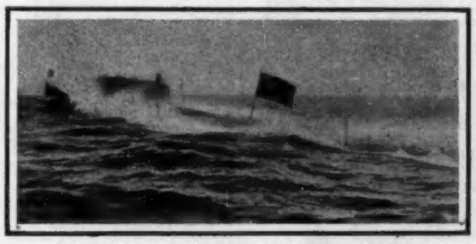
BY OUR ENGLISH CORRESPONDENT.

Great interest is being displayed in British motorboat circles in this year's contest for the Harmsworth trophy, which is to be decided in Long Island Sound the 1st of August, the cup having been won from France last year by the "Dixie," the representative of the Motor Boat Club of America. The British Motor Yacht Club has issued its challenge, and the first competitor, in which the greatest support for English supremacy will be centered, has already shown its speed ability in its first tests and in the Monaco races last April. The 400-horse-power Siddeley-Wolseley racer, which, as well as its powerful gasoline engines, is shown in the accompanying illustrations, is England's sole representative. Two days after the American victory of last year, the Wolseley Tool and Motor Company of Birmingham placed in hand the designs for a 1908 challenger, and in order that the craft should be thoroughly tuned up for the race in America, it was decided to enter it in the European races during the spring and summer. Therefore its construction was immediately begun.

In carrying out their designs, the builders decided to depart from the usual practice in such races of constructing a mere racing shell of fine lines, narrow beam, and extremely light displacement; but inclined rather toward installing plenty of power, by means of which high speed could be secured, and toward providing a greater proportion of horse-power to displacement. An engine set developing 400 horse-power at 1,000 revolutions per minute and driving twin screws was determined upon as the most satisfactory solution of the problem, and it was estimated that this high power could be secured with a weight of 3,900 pounds, giving a displacement in racing trim of 70 hundredweight, which would give a ratio of 5.7 horsepower per hundredweight of displacement.

In view of the fact that it was intended that this craft should participate in the Monte Carlo races, the hull had to be of substantial design to withstand the severe strains arising from propulsion at high speed in the heavy swell of Monaco Bay. The hull was built at the Cowes yard of Messrs. S. E. Saunders & Co. upon their well-known system, the success of which has been conspicuous in the past in regard to speedy strong vessels of this class. It measures 39 feet 4 inches in length by 6 feet beam, and has a maximum draft at the propellers of 32 inches. Wood has been utilized exclusively in the construction of the hull, which is built up of three skins. The outer sheathing is of mahogany laid horizontally, in single pieces from stem to stern without a butt; the second layer is of special oak disposed diagonally, while the internal skin is of the same wood laid vertically, so that an unusually strong hull is secured with a minimum of weight. Between each sheathing of wood waterproof silk is placed. The skins are riveted to oak timbers placed 4½ inches apart, and between these timbers the three sheaths of wood are sewn together upon the Saunders system with copper wire. The main foundation is of Oregon pine sawn in one piece from stem to stern, to which is clenched a mahogany girder similarly running from end to end and braced diagonally. The boat is decked fore and aft with the exception of the engine space and cockpit, about 15 feet in length, which is protected by a waterproof canvas hood. With regard to the water lines of the hull, these are straight for a distance of 12 feet from the perpendicular stem, with a considerable flare above the waterline to lift the bow in a seaway. As the stern is approached, a rounded and flattened effect is secured.

The motors, while following the general Wolseley practice, contain several interesting features. No attempt has been made to sacrifice strength for lightness, the latter effect only being carried out in connection with the less important details, the crankshafts, pistons, etc., only being decreased in weight by the extensive utilization of Vickers high-tensile nickelchrome steel. The twin-screw principle of installation



This boat's record is 34.71 miles an hour for a kilometer.

The Wolseley-Siddeley Speeding at Monaco.

was decided upon in order to secure great structural strength in the motors, considering their high power, the concentration of the weight amidships insuring complete seaworthiness, combined with the benefits accruing from entirely separate units giving duplication of driving power and balancing of propeller torque.

Each engine consists of eight cylinders cast in pairs and bolted to one crankcase. With regard to the cylinders, instead of their being cast in one piece with the water jacket, the latter is of planished copper separately fitted. By this means it was rendered possible to obtain access to the inside of the jacket after the castings had been made. The copper jacket is screwed to the cast-iron cylinder casting, the principle adopted being plainly discernible in the illustrations. This arrangement has many advantages, since it is always possible to examine the internal surface of the cylinder wall, water circulation space, and so forth. Special attention has been devoted to the provision of ample water-cooling space around the valve pockets. The valves are mechanically operated, and are placed side by side along the front of the engine, the vaporizer being the only part of the mechanism carried on the rear side.

The water circulation is of the most complete description, so as to obviate the possibility of breakdown through any failure in this direction. The water is forced through the circulation system by means of powerful centrifugal pumps, two to each engine, driven from a universally-jointed shaft connected with the gear on the forward end of the motors, the supply being obtained through suctions placed abaft the motor. The vaporizer is fixed high up on the outside of the engine, the gas feed being through large-diameter pipes to the various inlet valves. The ignition is both high-tension electric with accumulator and coil and high-tension magneto, the engine being started up on the former (which is also used as a stand-by) and then switched on to the latter. Lubrication is of the automatic type, oil being supplied at a temperature not exceeding 110 deg. Fahr. to all the important bearings at a pressure of 12 pounds per square inch. The clutches are of the cone type in conjunction with a positive locking arrangement. Hoffman ball bearings carried in gun-metal boxes held by trunnions are used for the thrust bearings, and are mounted on the same shaft as the clutches.

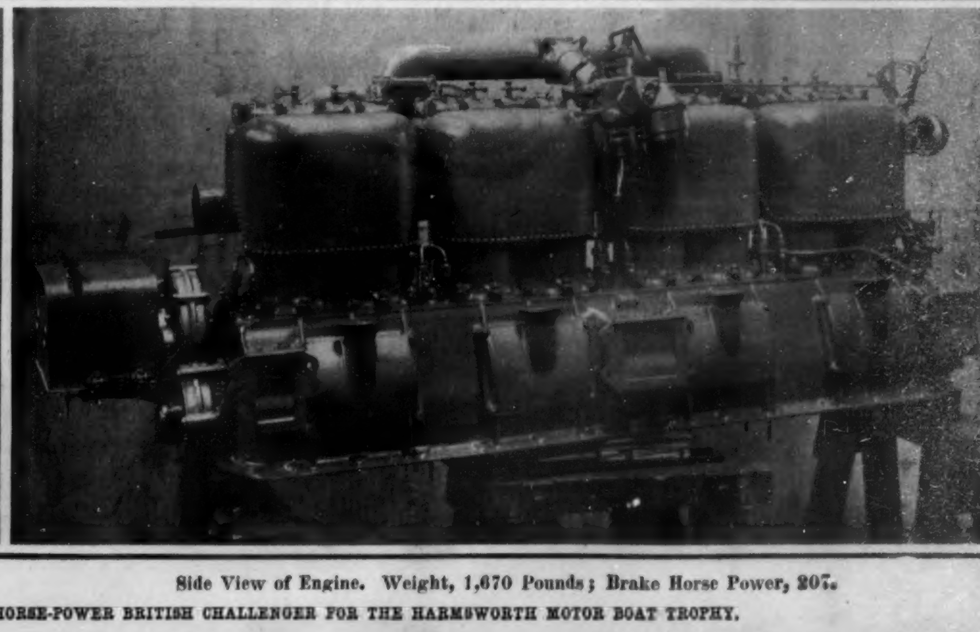
Owing to the distance between the crankshafts of the pair of motors being governed by the beam of the boat, and all valves, etc., being placed on the inside face of the motors, in order to permit entrance between the engines when installed, for access to these parts, the engines are set at a slight angle from the vertical. In this way the engineers will have sufficient space to attend to the working parts on either side. The angle at which the engines and propeller shafts are set is 11 deg. from the horizontal. The shafting itself is fashioned from Vickers axle carbon steel of 1 11/16-inch diameter.

The engines in running condition each weigh 1,670 pounds, and have each developed more than 207 brake horse-power at the normal running speed of 1,000 revolutions per minute. The machinery complete weighs 4,200 pounds. It is generally conceded that this challenger will prove both seaworthy and speedy, and unlike the conventional craft of this type, it is not a mere shell, but will withstand severe buffeting in heavy seas.

The performances of this boat at Monaco showed well the staunchness of the hull. The small illustration of the boat traveling at full speed in Monaco Bay shows the tremendous spray that it throws when there is any sea running. The lines of the hull are such, however, that its spray-throwing qualities are not so great as those of some of the French racers, such as the new Panhard-Levassor, for example. In the mile and kilometer trials at Monaco the Wolseley-Siddeley and the Panhard-Levassor boats were both evenly matched. The mile trials were made from a standing start, and the two boats tied in the final, each covering the distance in 2 minutes 1 1/5 seconds. The latter boat made the faster time in the flying kilometer test, as it covered this distance in 1 minute 2 4/5 seconds, at the rate of 35.6 miles an hour. The Wolseley-Siddeley covered this distance in 1 minute 4 2/5 seconds, which was at the rate of 34.71 miles an hour. In the longer races at Monaco, the Wolseley-Siddeley covered 31.05 miles in 54 minutes and 57 seconds, or at the rate of 33.87 miles an hour. The 124.2-mile "championship of the sea" race was won by the Panhard-Levassor in 3 hours, 46 minutes, and 2 seconds, at average speed of 32.97 miles an hour.

Up to the present time there have been no entries of American boats for the race for the Harmsworth trophy to be held in Long Island Sound on August 1. If more than three boats are entered, elimination trials will be held on July 10 and 11. This event will be the first international motor boat race of importance to be held in America, and it should do much toward stimulating the sport. The Wolseley-Siddeley racer has been entered by her present owner, the Duke of Westminster.

End View of One of the Engines.



Side View of Engine. Weight, 1,670 Pounds; Brake Horse Power, 207.

ENGINES OF THE 400 HORSE-POWER BRITISH CHALLENGER FOR THE HARMSWORTH MOTOR BOAT TROPHY.

RECENTLY PATENTED INVENTIONS.

Of General Interest.

EXTENSIBLE PICTURE-FRAME.—J. A. Watt, New York, N. Y., and A. W. Watt, Wilkes-Barre, Pa. The object of the improvement is to produce an extensible frame which may be conveniently used by artists for temporarily mounting a canvas within a frame in order to observe the resulting effect. It will present the same ornamental appearance when extended as when contracted.

APPARATUS FOR DRAWING PERSPECTIVE VIEWS.—E. Meyer, Schneverdingen, Prussia, Germany. The chief feature is that one of the pivots affording guidance for the pencil, or the like, coincides with the pivot at which the lines of projection from the plan and elevation cut each other. This pivot can be attached to a vertical double winged frame, which can be moved in all directions over the plan view, for which purpose a pointer is provided vertically underneath the cutting point of the lines of projection.

FOLDING UMBRELLA.—C. Stone, Battle Creek, Iowa. The purpose here is to provide a construction which will facilitate the folding of the ribs, will hold them secured when extended, will reliably hold the frame in opened adjustment, afford three telescopic sections, for the umbrella frame stick, and afford means for releasably holding these stick sections extended or telescopically contracted.

ROTARY REACTION-MOTOR.—G. W. Barber, Sr., Jacksonburg, W. Va. The aim in this case is to construct a motor for use for various purposes, but more especially for diffusing and distributing disinfectants, medicinal vapors or perfume in a room, and for use as a toy, and which in some applications may be useful for turning light mechanical toys, dentists' and jewelers' lathes, to operate revolving flybrushes, or even sewing machines, or other machinery.

CHUTE.—S. W. Brown, Colorado Springs, Col. An object of the inventor is to provide a light chute adapted to be arranged at an opening in a wall and having a tilted hopper for directing the material through the opening and serving as a closure for the opening when the hopper is in an inoperative position.

LADDER.—A. S. Asch, New York, N. Y. The invention has reference to improvements in ladders, and more particularly to that type adapted to be supported at the upper end upon a track or runway, and so connected thereto that the ladder may be freely moved along the track or set at any desired angle thereto. The object is to provide means adapted to be secured to any ordinary ladder whereby it may be used in the manner above indicated.

DENTAL DAM-HOLDER.—C. A. Conover, Newburg, N. Y. The purpose of the inventor is to so construct a holder for dentists' use, that the frame will be flexible and provided with removable rubber pads adapted to lie next the face, thus rendering the holder cool and comfortable to the wearer, and enabling the dentist to remove and sterilize the pads each time the device is used.

Heating and Lighting.

STEAM-HEATER.—G. R. Nixon, Pittsfield, Mass. The improvement pertains to heaters, the more particular object being to provide a heater of relatively high efficiency, and in which a flowing medium such as steam or hot water, can be made to impart a large proportion of its heat to a pipe extending through the heater.

Household Utilities.

BOX-SPRING.—J. M. Bowers and W. R. Close, New York, N. Y. A box spring is provided with an end section capable of being raised and lowered without breaking the continuity of the accompanying mattress section, and whereby such section may be elevated to an angle and held at such elevation. Means are provided whereby the occupant can lower the elevated section partially or entirely without leaving the bed, and when said section is in lowered position, it is supported by the main frame in horizontal alinement with a fixed section.

Machines and Mechanical Devices.

SOUND-REPRODUCER.—R. B. Smith, 937-9 Broadway, New York, N. Y. The reproducer is such as is employed in connection with talking machines. The more particular object of the inventor is to provide for greater freedom of movement of the stylus lever in order to permit a more faithful reproduction of the vibrations and to avoid undue wear upon the record and stylus. Means permit the lever to travel freely in a direction lateral to the general direction of travel of the diaphragm. Mr. Smith is also inventor of a revolving aerial automobile illusion with lady in it, a shadow clock showing time on the sidewalk, and a triple phonograph speaker in which three records are played at one time.

ATTACHMENT FOR TALKING-MACHINES.—W. A. Chapman, Smithville, Ark. The machine admits of general use, but is of peculiar value in connection with sound reproducers employed upon disk talking machines. Among the purposes of the inventor are general improvement of the tones, amelioration of the scratching and metallic hardness and the development of delicate sounds difficult of reproduction.

AIR-SHIP.—G. Bold, Plainfield, N. J. Both the car or hull and the gas-bag are composed of a plurality of jointed sections, the adjacent sections of the hull and bag being connected together, forming the ship into a plurality of sectional parts movable in relatively different planes whereby considerable flexibility is afforded, making it possible to change the direction of flight both horizontally and vertically, with facility.

CLOCK-MOVEMENT.—G. Sylvan, J. B. Sylvan, and E. W. Sylvan, Columbia, S. C. The intention in this patent is to provide means for securing a more uniform transmission of power from the main spring of a clock or watch, to its escapement, to render the same more accurate in its time keeping values. When the mainspring is wound to its maximum tension it transmits its power more energetically than when relaxed and nearly run down. The invention overcomes this irregularity.

AUTOMATIC DUMPING DEVICE.—J. W. Weaver, Skidoo, Cal. One object of this improvement is to provide a device having an apron operated by the movement of the bucket, partially to cover the shaft or excavation, to prevent the accidental return of part of the contents of the bucket when the latter is dumped, and having supporting means controlled by the movement of the bucket for holding the bucket in the dumping position.

Note.—**Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.**

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Gas purifying apparatus, E. Higgins 889,229
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Harvesting machines, bundle carrier and dropper for, Ferris & Dikeman 889,672
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Sewing machine for finishing buttonhole pieces, etc., H. E. Hill.......... 889,882
Sewing machine shuttles, bobbin holder for, H. A. Bates.......... 889,501
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